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NATIONAL DAM INSPECTION PROGRAM. LAUREL RUN NUMBER 2 DAM. (NDI --ETC(U)
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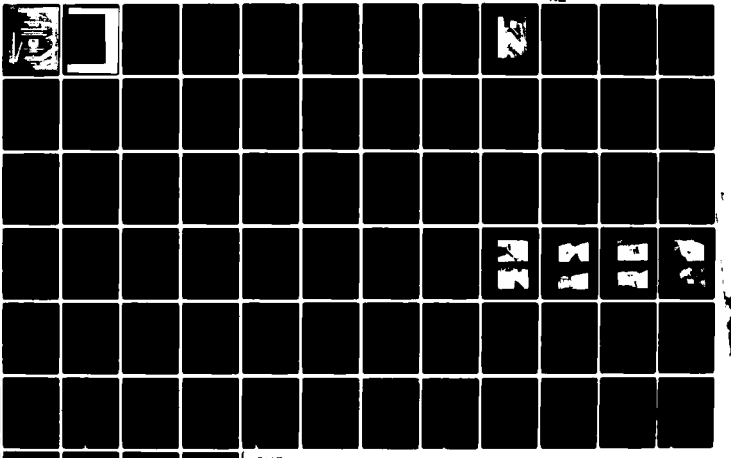

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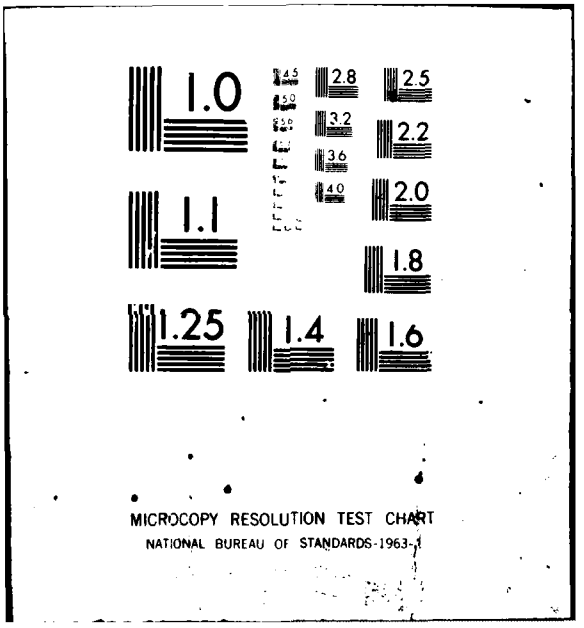
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GANNETT FLEMING CORDDRY AND
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SUSQUEHANNA RIVER BASIN,
LAUREL RUN, LUZERNE COUNTY,
PENNSYLVANIA.

(6) NATIONAL DAM INSPECTION PROGRAM.
LAUREL RUN No. 2 DAM.
(NDI ID Number PA-00550,
DER ID Number 40-23)
[redacted]

PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM

(10) Frederick/Futchko

(15) DACW31-80-C-0017

Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
P.O. Box 1963
Harrisburg, Pennsylvania 17105

For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

(11) APR 80

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PREFACE

This report is prepared under guidance contained in the *Recommended Guidelines for Safety Inspection of Dams*, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

SUSQUEHANNA RIVER BASIN

LAUREL RUN, LUZERNE COUNTY

PENNSYLVANIA

LAUREL RUN NO. 2 DAM

NDI ID No. PA-00550
DER ID No. 40-23

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

APRIL 1980

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Laurel Run No. 2 Dam NDI ID No. PA-00550 DER ID No. 40-23
Size:	Small (37 feet high; 122 acre-ft)
Hazard Classification:	High
Owner:	Pennsylvania Gas and Water Company J. Glenn Gooch, President 39 Public Square Wilkes-Barre, PA 18711
State Located:	Pennsylvania
County Located:	Luzerne
Stream:	Laurel Run
Date of Inspection:	25 October 1979

Based on available records, visual inspection, calculations, and past operational performance, Laurel Run No. 2 Dam is judged to be in good condition. The spillway will pass about 7 percent of the Probable Maximum Flood (PMF) before overtopping of the dam occurs. The recommended Spillway Design Flood (SDF) for the size and hazard classification of the dam varies between the 1/2 PMF and the PMF. Based on the criteria and the downstream conditions, the SDF is the PMF. The spillway capacity is rated as inadequate. It is judged that the dam could withstand the depth and duration of overtopping that would occur for the PMF. Records show that the dam has withstood an overtopping of 7 feet.

next page

No stability problems were evident at the dam. Although there is significant leakage at the masonry joints in the dam, records show that the leakage has existed for at least 65 years without any detrimental effects on the dam. The leakage is judged not to be a hazard to the dam at present.

The ability of the emergency drawdown valve to function is uncertain because it has not been operated recently.

The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, without delay:

(1) Ensure the operational adequacy of the emergency drawdown facilities and operate the valve on a regular basis.

(2) Monitor the scoured area at the toe of the spillway. If a significant increase in scour is noted, take appropriate action as required.

(3) Monitor the leakage at the masonry joints of the dam. If a significant increase in the leakage is noted, take appropriate action as required.

(4) As part of the regular maintenance program, remove trees close to the toe of the dam and repoint deteriorated mortar at the capstones.

In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Laurel Run No. 2 Dam.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of Laurel Run No. 2 Dam.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

(4) As presently required by the Commonwealth, submit an annual inspection report for Laurel Run No. 2 Dam to the Commonwealth.

LAUREL RUN NO. 2 DAM

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 2 May 1980

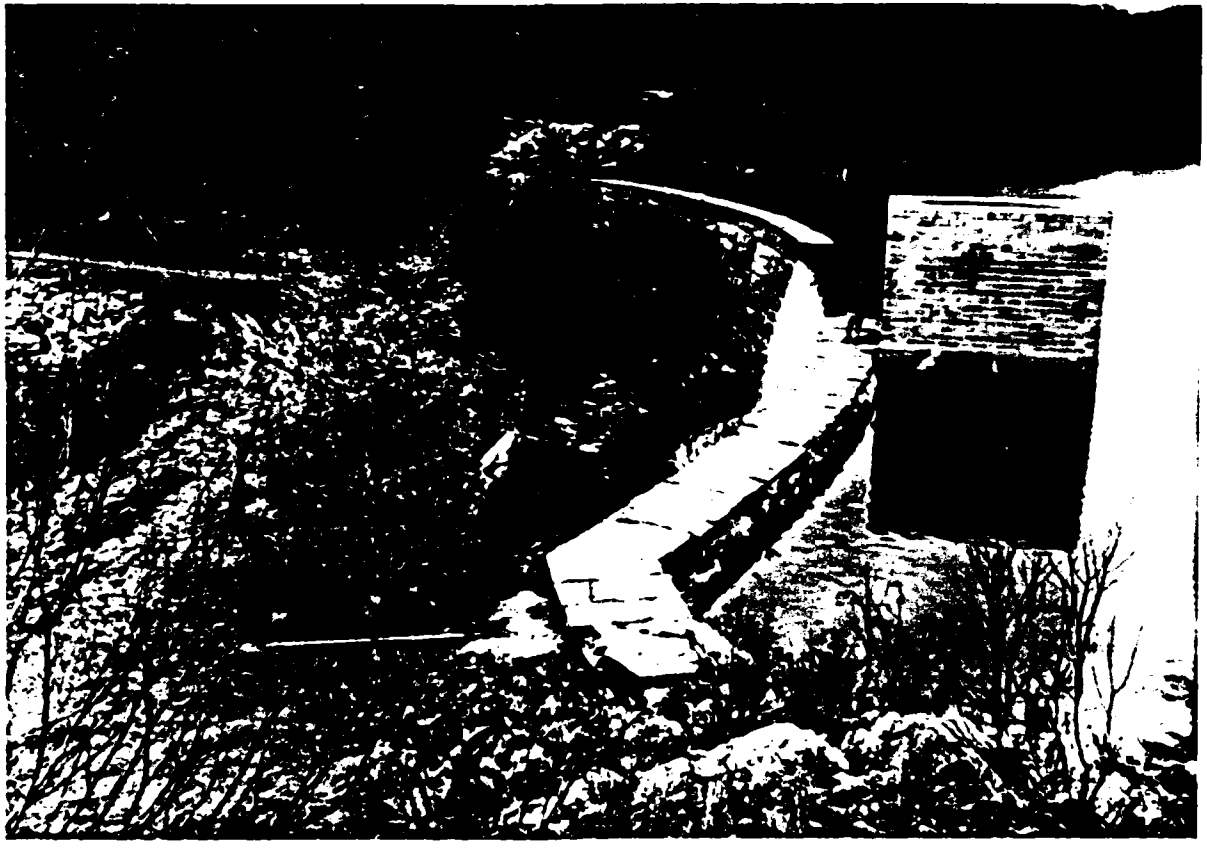
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 16 May 1980

LAUREL RUN NO. 2 DAM



Overview

SUSQUEHANNA RIVER BASIN

LAUREL RUN, LUZERNE COUNTY

PENNSYLVANIA

LAUREL RUN No. 2 DAM

NDI ID No. PA-00550
DER ID No. 40-23

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

APRIL 1980

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Laurel Run No. 2 Dam is a stone masonry arch dam. It is 298 feet long, 37 feet high, and it has a topwidth of 5.2 feet. The axis of the dam extends over a 63° 31' arc on a 247-foot radius.

The spillway is part of the masonry arch. It is 61 feet long and its crest is 2.5 feet below the top of the dam. A concrete apron is at the downstream toe of the spillway.

An access road extends across the valley immediately downstream from the dam. The access road crosses the stream on an 18-foot high embankment. The stream flows beneath the access road through a horseshoe conduit.

The outlet works consists of a concrete and stone masonry intake structure that is just to the left of the spillway, a sluice gate, and a 24-inch diameter cast-iron pipe (CIP). The sluice gate is located in the intake structure. The pipe extends from the sluice gate through the dam. The pipe is exposed just downstream from the dam. It extends along the streambed, through the horseshoe conduit at the access road, and it connects to the water supply system. Emergency drawdown facilities consist of an 18-inch diameter CIP that taps off the 24-inch diameter water supply line inside the horseshoe conduit. A valve is provided at the tap. The outfall of the 18-inch diameter line is just downstream from the access road fill. The various features of the dam are shown on the Photographs in Appendix C and on the Plates in Appendix E. A description of the geology is included in Appendix F.

b. Location. Laurel Run No. 2 Dam is located on Laurel Run in Plains Township, Luzerne County, Pennsylvania, approximately 1.4 miles south of the Pocono Downs Racetrack. Laurel Run No. 2 Dam is shown as the Colebrook Dam on USGS Quadrangle, Wilkes-Barre East, Pennsylvania, at latitude N 41° 14' 55" and longitude W 75° 49' 05". A location map is shown on Plate E-1.

c. Size Classification. Small (37 feet high, 122 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Laurel Run No. 2 Dam (Paragraphs 3.1e and 5.1c (5)).

e. Ownership. Pennsylvania Gas and Water Company, J. Glenn Gooch, President, 39 Public Square, Wilkes-Barre, Pennsylvania.

f. Purpose of Dam. Water Supply.

g. Design and Construction History. Laurel Run No. 2 Dam was built in 1885 by Joseph Hendler, a contractor from Wilkes-Barre. The construction was supervised by William H. Sturdivant, Chief Engineer of the Wilkes-Barre Water Company, who was the original owner.

Since its original construction, the screen house upstream from the dam has been rebuilt several times. The dam has also been overtopped several times, as noted in Section 5. The only recorded damage because of the overtoppings was to the screen house.

In 1914, an apron was added at the toe of the spillway. It was rehabilitated around 1950, by covering it with concrete. In 1953, the right end of the dam was rebuilt with concrete.

h. Normal Operational Procedure. The pool is maintained at the spillway crest level with excess inflow discharging over the spillway. The emergency drawdown facility is normally not used. Spillway discharge flows downstream to the confluence with Mill Creek.

1.3 Pertinent Data.

a.	Drainage Area. (square miles)	8.5
b.	Discharge at Damsite. (cfs.)	
	Maximum known flood at damsite	17,900
	Outlet works at maximum pool elevation	60
	Spillway capacity at maximum pool elevation	800
c.	Elevation. (feet above msl.)	
	Top of dam	852.6
	Maximum pool	852.6
	Normal pool (spillway crest)	850.1
	Upstream invert outlet works	821.0

c.	Elevation. (cont'd.)	
	Downstream invert outlet works	820.0
	Streambed at toe of dam	816.0
d.	Reservoir Length. (miles)	
	Normal pool	.19
	Maximum pool	.20
e.	Storage. (acre-feet)	
	Normal pool	107
	Maximum pool	122
f.	Reservoir Surface. (acres)	
	Normal pool	5.5
	Maximum pool	6.1
g.	Dam.	
	Type	Stone Masonry Arch.
	Length (feet)	298
	Height (feet)	37
	Topwidth (feet)	5.2
	Sides Slopes	
	Upstream	8.93V on 1H
	Downstream	8.93V on 1H
	Zoning	None.
	Cut-off	Dam founded on bedrock.
	Grout Curtain	None.
h.	Diversion and Regulating Tunnel.	None.
i.	Spillway.	
	Type	Broad-crested weir with inclined top.

i.	Spillway. (cont'd.) Length of Weir (feet)	61.0
	Crest Elevation	850.1
	Upstream Channel	Reservoir.
	Downstream Channel	Concrete apron.
j.	Regulating Outlets. Type.	One 18-inch dia. CIP tapping into 24-inch dia. water supply line.
	Length (feet)	117
	Closure	18-inch gate valve and sluice gate at upstream end of water supply line.
	Access	In conduit beneath access road.

SECTION 2

ENGINEERING DATA

2.1 Design

a. Data Available. No design data are available for review. In 1914, the Pennsylvania Water Supply Commission (PWSC) analyzed the existing structure and prepared a report on it. The findings are discussed in other sections of this Report.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the Photographs in Appendix C and on the Plates in Appendix E.

c. Design Considerations. There are insufficient data to assess the design.

2.2 Construction.

a. Data Available. No construction data are available for review.

b. Construction Considerations. There are insufficient data to assess the construction.

2.3 Operation. There are no formal records of operation. A record of operation does exist in the form of inspection reports prepared by the Commonwealth between 1919 and 1964 as well as various inspections by the Owner. The findings of the previous inspections are discussed in other sections of this Report.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER). The Owner made available an engineer for information during the visual inspection. He also researched his files for information at the request of the inspection team.

b. Adequacy. The type and amount of available design data and other engineering data are very limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. Except for the maximum known flood at the damsite, there is no reason to question the validity of the available data. The 1914 PWSC Report states that the maximum known flood at the damsite occurred in 1887 when the dam was overtopped by 7 feet. The specific source for this data was not noted. Although this maximum flood of record is in excess of most floods that have occurred in Pennsylvania on streams with similar drainage areas (8.5 square miles), the magnitude is not above a possible value. One reason to question this data is the lack of extreme flooding recorded in adjacent watersheds or in the general area of the dam on the date of the flood of record. Considering the date of the occurrence of this flood, it is also possible that floods of similar magnitude occurred in adjacent watersheds but were just not recorded. Considering these factors and considering that the storm could have been a localized event, the data on the maximum known flood cannot be excluded and is considered as valid. It is used in this Report.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The overall appearance of the dam is good. Deficiencies were observed as noted below. A sketch of the dam with the locations of deficiencies is presented on Exhibit B-1 in Appendix B. Survey information acquired for this Report is summarized in Appendix B. On the day of the inspection, the pool was at the spillway crest level.

b. Dam. The most striking condition evident at the dam are the numerous leaks through the masonry joints. Because of the number of leaks, it is not possible to sketch the location of all of them. The locations of the more sizeable leaks are noted in Appendix B. To the right of the spillway, the two largest leaks were estimated at 5 gpm each. Near the right abutment, the dam is leaching and damp. The section of the dam at the right abutment is concrete with masonry facing. In summary, the total leakage to the right of the spillway was estimated at 15 to 20 gpm. One small seepage area was observed at the right abutment where water was seeping from the bedrock. The dam firmly abuts the bedrock at the right abutment (Photograph B).

The leakage to the left of the spillway is more severe. The largest leak observed was estimated at over 100 gpm. Another large leak of about 25 gpm and many minor leaks were observed. The top of the dam at the left abutment deflects upstream, away from the arch (Photograph C). This only affects the upper four feet of the dam. As viewed underwater, the remainder of the arch at the left abutment firmly abuts bedrock.

There are rock outcrops at both abutments. The rock at both abutments is a hard, massive sandstone of good quality. There was no evidence of any signs of stress where the dam abuts the rock outcrops.

To the right of the spillway, trees are growing close to the toe of the dam. Small brush and grass are growing in some of the masonry joints. The mortar in the

masonry joints is deteriorated, especially at the joints that are leaking, and by the capstones to the left of the spillway.

The survey performed for this inspection reveals that the top of the dam is above its design elevation. The minor variations shown on the profile are caused by the roughness of the capstones. The downstream face of the dam appeared to be in conformance with cross sections on the Plates in Appendix E.

c. Appurtenant Structures. The only deficiency observed at the spillway crest is a crack extending through one capstone. The crack was viewed underwater and is estimated to be 1/4 to 1/2 inch wide. The spillway apron is in good condition, except at its edges, where it appears to have deteriorated (Photograph G).

The single outlet works pipe is exposed downstream of the spillway apron (Photograph G). It extends through the conduit that passes under the downstream access road. In the middle of the conduit, an emergency drawdown line and valve tap off the water supply pipe. The valve is adjacent to the conduit wall and it seemed that it would be difficult to operate. The outfall of the emergency drawdown line is downstream from the access road (Photograph H). The Owner declined to operate the emergency drawdown line because its operation affects the quality of the water supply. He stated that it had not been operated in four years.

d. Reservoir Area. The watershed slopes are generally steep. The watershed is over 90 percent wooded. Two rural communities and some major roads are within the watershed. Mapping indicates that there are 5 impoundments within the watershed. Four of the impoundments were not visited on the day of the inspection because the pool areas indicated that the storage would be insignificant. The fifth impoundment, which is 1.8 miles east of Laurel Run No. 2 Dam, was visited on the day of the inspection. It is breached.

Mill Creek Canal, which is part of the Owner's water supply system, diverts water from Mill Creek to Laurel Run, just upstream of Laurel Run No. 2 Reservoir.

Along the reservoir shore, the slopes are steep and wooded. Several outcrops are in the reservoir area.

e. Downstream Channel. About 75 feet downstream from Laurel Run No. 2 Dam is the previously noted access road. A profile of the road and the conduit beneath are shown in Appendix B. About 900 feet downstream from the dam is the Interstate Route No. 81(I-81) roadway embankment at its interchange with Pa. Route No. 115 (PA-115). The top elevation of both the I-81 and the PA-115 embankments are well above the top elevation of Laurel Run No. 2 Dam. Culverts extend through both embankments with an open area between the embankments. The profile of the downstream area and the culverts are shown in Appendix B. About 0.25 mile downstream from the I-81 and PA-115 embankments, Pa. Route No. 315 (PA-315) crosses Laurel Run on a small bridge. The Treadway Inn is just upstream from this bridge. Some units of the Treadway Inn are level with the top of the PA-315 bridge railing. Downstream from the PA-315 bridge, there are no dwellings along Laurel Run for 0.9 mile. Further downstream, Laurel Run flows through part of Wilkes-Barre to its confluence with Mill Creek.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at spillway crest, with excess inflow discharging over the spillway and into Laurel Run. Water supply lines at the dam are connected directly to the Owner's distribution system. The emergency drawdown facilities are normally not used. Water supply demand at the dam, which occurs only during the summer and fall, is usually 2 to 4 mgd.

4.2 Maintenance of Dam. The dam is visited daily by a caretaker who records the reservoir elevation. Weekly reports are mailed to the Owner's Engineering Department. This information is used by the Owner's Engineering Department for regulating flows in the distribution system. The caretaker is also responsible for observing the general condition of the dam and appurtenant structures and reporting any changes or deficiencies to the Owner's Engineering Department. A Pennsylvania Gas and Water Company engineer makes a formal inspection of the dam each year, and the records are filed and used for determining priority of repairs. Informal inspections are also made when the engineer is on the site for other reasons. In response to the National Dam Inspection Program of the two previous years, the Owner has modified his maintenance and inspection programs. All maintenance, except for minor items, is performed under contract with outside firms. The Owner's operating personnel observe the maintenance performed by outside firms in order to become familiar with required maintenance work. The Owner plans to have all maintenance work performed by his operating personnel within a few years. The emphasis of the maintenance work has been placed on those structures previously inspected under the National Dam Inspection Program. Annual inspection reports for those dams inspected under the National Dam Inspection Program are submitted to the Commonwealth.

4.3 Maintenance of Operating Facilities. The emergency drawdown valve is operated infrequently. It has not been operated for about four years. Maintenance for the water supply outlet is performed on an as needed basis.

4.4 Warning Systems in Effect. The Owner furnished the inspection team with a verbal description of the chain of command diagram for Laurel Run No. 2 Dam and of a generalized emergency notification list that is applicable for all of the Pennsylvania Gas and Water Company dams. The Owner said that during periods of heavy rainfall, available personnel are dispatched to the dams to observe conditions. All company vehicles are equipped with radios, and the personnel can communicate with each other and with a central control facility. Evaluation of risk is made by the Owner's Engineering Department. The Owner's Engineering Department is also responsible for notification of emergency conditions to the local authorities. Detailed emergency operational procedures have not been formally established for Laurel Run No. 2 Dam, but are as directed by the Owner's Engineering Department.

4.5 Evaluation of Operational Adequacy. The maintenance of the emergency drawdown facilities is inadequate. Except for the leaks at the dam, as assessed in Section 6, the maintenance of the dam is adequate. The inspection program for the dam is good. A detailed emergency operation and warning system is necessary to reduce the risk of dam failure should adverse conditions develop and to prevent loss of life should the dam fail.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. There are no design data. In their 1914 Report, the Pennsylvania Water Supply Commission estimated the spillway capacity at 800 cfs. This estimate appears reasonable and is used in the analysis described in Appendix D.

The drainage area of 8.5 square miles, which is used in this Report, is taken from recent USGS mapping. The drainage area of 6.3 square miles, which is the record value, dates from 1914 or earlier.

b. Experience Data. The records indicate that the dam has been overtopped at least four times. Overtoppings of about 6 inches occurred twice prior to 1914 and in September 1924. The 1914 PWSC Report indicates that the flood of record occurred in 1887, when the dam was overtopped by 7 feet. The only reported damage was to the upper portions of the screen house, which washed away. The inspector for the PWSC expressed disbelief at the depth of the overtopping, because the flow was much larger than the maximum expected flow.

c. Visual Observations.

(1) General. The visual inspection of Laurel Run No. 2 Dam, which is described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics. These observations are evaluated herein for the various features.

(2) Dam. No deficiencies pertinent to hydrology and hydraulics were observed at the dam.

(3) Appurtenant Structures. Although the edges of the spillway apron appear to be deteriorated, photographs in the Owner's files indicate that the edges were raggedly constructed. The apron appears to be in the same condition that it was 25 years ago. As such, there is no concern for its integrity.

The streambed at the toe of the dam is 3 to 4 feet lower than the streambed immediately downstream. Constant spillway flows have probably scoured a hole in the bedrock at the toe of the spillway. The spillway apron has a key of uncertain depth, as indicated on Plate E-4. The apron was probably added to prevent the scour from worsening. As there is only one survey record of the scoured area, monitoring it appears to be warranted.

Although the emergency drawdown facilities would obviously be inaccessible for significant flows at the dam, this is not of concern because its contribution to the discharge would be negligible during periods of significant flow. At present, its operation is uncertain because it has not been operated or maintained for four years.

(4) Reservoir Area. The development in the watershed will not have a significant effect on the hydrology at the damsite. Neither will the Mill Creek Canal have a significant effect on the hydrology at the damsite. The one impoundment of significant size in the watershed is breached. Although it may store some water during a flood, this is not considered to have any significant effect on the hydrology at the damsite.

(5) Downstream Conditions. For large flows at the damsite, the access road immediately downstream would overtop and probably wash out. As there would be adequate access to the right abutment of the dam, the washing out of the access road is not of concern. The I-81 and PA-115 embankments downstream would have a significant mitigating effect on floodflows. The embankments would not overtop because of a failure of the dam. However, even with the mitigating effects, a failure of the dam would probably cause flow over the PA-315 bridge and result in flooding at the Treadway Inn with the potential for loss of life.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (Small) and hazard potential (High) of Laurel Run No. 2 Dam is between one-half of the Probable Maximum Flood (PMF) and the PMF. Because of the downstream

conditions, the PMF is selected as the SDF for Laurel Run No. 2 Dam. The watershed was modeled with the HEC-1DB computer program. A description of the model is included in Appendix D. The assessment of the dam is based on existing conditions, and the effects of future development are not considered.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that Laurel Run No. 2 Dam can pass about 7 percent of the PMF before overtopping of the dam occurs. During the PMF, the dam would overtop for 21 hours to a maximum depth of 5.6 feet.

(3) Spillway Adequacy. The criteria used to rate the spillway adequacy are described in Appendix D. The spillway capacity is rated as inadequate. As described in Section 6, it is judged that the dam could withstand an overtopping by the PMF without serious damage.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations.

(1) General. The visual inspection of Laurel Run No. 2 Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Dam. The records are replete with observations of both inspectors from the Commonwealth and other parties concerning the leaks at the dam. The available records indicate that the dam has leaked severely since the first inspection in 1914. The Owner reported verbally that attempts to stop the leaks have been made at various times. These attempts included repointing masonry joints, grouting, and placing wood in the masonry joints under the assumption that the wood would swell and therefore reduce leakage. The attempted repairs have not been successful. Although leakage through the masonry joints of the dam is undesirable, the leakage has been occurring for at least 65 years with no apparent detrimental effect on the structural integrity of the dam. Considering both the past history and the good structural condition of the dam, the leaks are not deemed to be a hazard to the safety of the dam at present. However, as there are no detailed records of the leakage, monitoring the leakage is warranted in order that any changes in the condition can be detected. The effect of the leakage on the water supply capability of the dam is not pertinent to this Report.

Above normal pool level, the dam is not a true arch dam because of the spillway and the dogleg at the left abutment. Deterioration of the mortar in the joints above normal pool level could have an adverse effect on the stability of the upper portions of the structure. The roots of the trees at the toe of the dam could possibly extend through the bedding planes of the

bedrock and through the masonry joints; however, it is judged that they would only have a minor effect on the dam.

(3) Appurtenant Structures. The reason for the crack in the spillway crest capstone is unknown. It is possible that the crack developed when the capstone was placed or it might be the result of freeze-thaw action. It is probable that there are leaks in the masonry joints below the spillway crest. Such leaks would have been obscured by the spillway discharge.

No structural deficiencies were observed at the outlet works.

b. Design and Construction Data. There are no design and construction data. In their 1914 Report, the PWSC performed an approximate analysis on the dam. They computed a pressure of 434 psi at the abutments using a thin-cylinder analysis and assuming an overtopping of 1 foot. They also used a 28-foot height of dam, an arch radius of 276 feet, and a dam thickness of 8 feet, assuming no upstream batter.

Using the same method of analysis, but using data shown on Plates E-2 to E-5, which were not available to the PWSC, the maximum stress for 1 foot of overtopping computes to be 310 psi. For 7 feet of overtopping, the stress increases to 360 psi. These stresses are well within the compressive stresses usually allowed for masonry and concrete, as well as being far below the allowable compressive strength of the sandstone bedrock.

The thin-cylinder method of analysis is a simplified approach and is not strictly applicable to an arch dam; however, many arch dams have been successfully designed with this method. Its use generally has been limited to dams that were 30 feet or less in height. Although Laurel Run No. 2 Dam has a maximum height of 37 feet, it is believed that the results obtained with this method were sufficiently conservative for the method of analysis to be considered acceptable.

The thin-cylinder method of analysis does not reveal the ability of the rock abutments to withstand the loads from the arch dam. Detailed geologic information on the rock abutments and test data on the rock would be needed

in order to fully address the compentency of the rock abutments to withstand the thrust from the dam. Although Plate E-2 shows locations of drill holes, no data concerning the borings could be found in the records. Even if sufficient data were available, a detailed analysis of the rock abutments is beyond the scope of this Report. During the visual inspection, both rock abutments were in good condition. There is no evidence suggesting that they could not withstand the loads imposed by the dam.

c. Operating Records. There are no formal records of operation. The available records indicate that, except for the leaks at the dam, all structures have performed satisfactorily. The dam has been overtopped on at least 4 occasions. One of the overtoppings was reportedly by 7 feet. As this is greater than the Probable Maximum Flood (PMF) overtopping, as described in Section 5, the ability of the dam to withstand a PMF loading is assumed to be adequate.

d. Post-construction Changes. Placing concrete at the right end of the dam, as described in Paragraph 1.2g, probably improved the structural integrity of the dam by reducing the stress at the rock abutment.

e. Seismic Stability. Laurel Run No. 2 Dam is located in Seismic Zone 1. Earthquake loadings are not considered to be significant for small dams located in Seismic Zone 1 when there are no readily apparent stability problems. As there are no readily apparent stability problems, the seismic stability of Laurel Run No. 2 Dam is assumed to be adequate.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on available records, visual inspection, calculations, and past operational performance, Laurel Run No. 2 Dam is judged to be in good condition. The spillway will pass about 7 percent of the PMF before overtopping of the dam occurs. The recommended Spillway Design Flood for the size and hazard classification of the dam varies between the 1/2 PMF and the PMF. Based on the criteria and the downstream conditions, the Spillway Design Flood is the PMF. The spillway capacity is rated as inadequate. It is judged that the dam could withstand the depth and duration of overtopping that would occur for the PMF. Records show that the dam has withstood an overtopping of 7 feet.

(2) No stability problems were evident at the dam. Although there is significant leakage at the masonry joints of the dam, records show that the leakage has existed for at least 65 years without any detrimental effect on the dam. The leakage is judged not to be a hazard to the dam at present.

(3) The ability of the emergency drawdown valve to function is uncertain, because it has not been operated recently.

(4) A summary of the features and observed deficiencies is listed below:

Feature and Location	Observed Deficiency
Dam:	Deteriorated mortar; grass and small brush in some masonry joints; leaks at masonry joints.

Feature and Location	Observed Deficiency
Spillway:	Crack in capstone; scour hole downstream from spillway.
Outlet Works:	Uncertain operation of emergency drawdown facilities.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented without delay.

d. Necessity for Further Investigations. Accomplishment of remedial measures outlined in Paragraph 7.2 will not require further investigations by the Owner.

7.2 Recommendations and Remedial Measures.

a. The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, without delay:

(1) Ensure the operational adequacy of the emergency drawdown facilities and operate the valve on a regular basis.

(2) Monitor the scoured area at the toe of the spillway. If a significant increase in scour is noted, take appropriate action as required.

(3) Monitor the leakage at the masonry joints of the dam. If a significant increase in the leakage is noted, take appropriate action as required.

(4) As part of the regular maintenance program, remove trees close to the toe of the dam and repoint deteriorated mortar at the capstones.

b. In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Laurel Run No. 2 Dam.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of Laurel Run No. 2 Dam.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

(4) As presently required by the Commonwealth, submit an annual inspection report for Laurel Run No. 2 Dam to the Commonwealth.

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: LAUREL RUN No. 2

NDI ID NO.: PA-00550 DER ID NO.: 40-23

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	DRAWINGS OF MODIFICATIONS SEE PLATES E-2 TO E-5
REGIONAL VICINITY MAP	SEE PLATE E-1
CONSTRUCTION HISTORY	BUILT 1895
TYPICAL SECTIONS OF DAM	SEE PLATE E-3
OUTLETS: Plan Details Constraints Discharge Ratings	SEE PLATES E-4 AND E-5 NO RATINGS OR CONSTRAINTS

A-1

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE
DESIGN REPORTS	NONE
GEOLOGY REPORTS	NONE
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	NONE
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	NONE
POSTCONSTRUCTION SURVEYS OF DAM	SEE PLATES E-2 TO E-5

A-2

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	UNKNOWN
MONITORING SYSTEMS	NONE
MODIFICATIONS	EARLY 1950's RIGHT ABUTMENT REPLACED WITH CONCRETE SPILLWAY APRON ADDED
HIGH POOL RECORDS	NONE
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	PENNSYLVANIA WATER SUPPLY COMMISSION. (PWSC) 1914 REPORT
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports ALSO SEE PREVIOUS INSPECTIONS.	PWSC REPORT: OVERTOPPED IN 1887 by 7' - SCREEN HOUSE WASHED OUT OVERTOPPED AT 2 OTHER TIMES by 6" ± NO DAMAGE REPORTED

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	NONE
SPILLWAY: **Plan** **Sections** **Details**	SEE PLATES E-2 TO E-4
OPERATING EQUIPMENT: **Plans** **Details**	NONE
PREVIOUS INSPECTIONS **Dates** **Deficiencies** by COMMONWEALTH	1919 - OPEN JOINTS, CONSIDERABLE LEAKAGE THROUGH JOINTS, LEAKAGE AT OUTLETS. 1924 - NO MAINTENANCE - LEAKAGE THROUGH JOINTS. ON 9/29/24 OVERTOPPED BY 4"-6" 1926 - LEAKAGE THROUGH JOINTS, SMALL TREES GROWING IN JOINTS; MASONRY SPILLWAY APRON UNDERMINED, NEEDS REPOINTING 1928 - CONSIDERABLE REPOINTING ACCOMPLISHED, STILL IS LEAKING CONSIDERABLY, GROUTING ACCOMPLISHED NEAR LEFT END, SPILLWAY APRON UNDERMINED.
(CONTINUED)	1930 - LEAKING UP TO A HEIGHT OF 12 FEET, FLOW FROM RIGHT END, WATER SUPPLY PIPE LEAKING

A-4

ENGINEERING DATA

ITEM	REMARKS
PREVIOUS INSPECTIONS (CONTINUED)	1931 - MANY LEAKS REPAIRED. 6 LEAKS STILL EVIDENT. 1933 - SEEPAGE TO LEFT OF SPILLWAY AND OVER LOWER 6' TO RIGHT OF SPILLWAY.
(CONTINUED)	1941 - MORTAR IN JOINTS DETERIORATING, GENERAL SEEPAGE OVER LOWER 2/3 OF STRUCTURE. 1943 - PER 1941 AND NOTES REPAINTING OF SOME JOINTS.
(CONTINUED)	1964 - LEAKAGE THROUGH MASONRY (JOINTS)

A-5

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: LAUREL RUN No. 2 County: LUZERNE State: PENNSYLVANIA

NDI ID No.: PA-00550 DER ID No.: 40-23

Type of Dam: MASONRY ARCH Hazard Category: HIGH

Date(s) Inspection: 25 October 1979 Weather: OVERCAST-INTERMITTENT SUN Temperature: 45-50°F

SOIL CONDITIONS: MOIST

Pool Elevation at Time of Inspection: 850.1 msl/Tailwater at Time of Inspection: 820.2 msl

Inspection Personnel:

D. WILSON (GFCC)

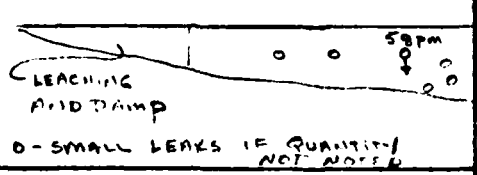
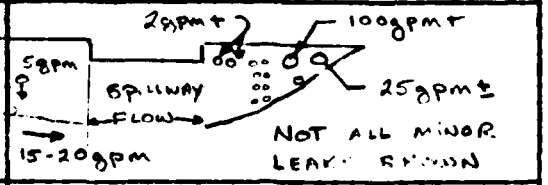
D. EBERSOLE (GFCC)

A. WHITMAN (GFCC) Recorder

B-1

CONCRETE/MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE DIAGRAM LOOKING UPSTREAM		
JUNCTION OF STRUCTURE WITH: **Abutment** **Embankment** **Other Features**	BOTH ABUTMENTS IN ROCK NO DEFICIENCIES	SMALL SEEP FROM RIGHT ABUTMENT HILLSIDE
DRAINS	NONE	
WATER PASSAGES	NONE VISIBLE	
FOUNDATION	BEDROCK	TREES GROWING CLOSE TO TOE.

CONCRETE/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES: **Surface Cracks** **Spalling**	ONLY AT RIGHT ABUTMENT UPSTREAM SIDE IS VISIBLE No deficiencies	
STRUCTURAL CRACKING	NONE	
ALIGNMENT: **Vertical** **Horizontal**	VERTICAL - SEE SURVEY DATA FOLLOWING INSPECTION FORMS. HORIZONTAL - ARCH - NO OBSERVED DEFICIENCIES	
MONOLITH JOINTS	MASONRY JOINTS MORTAR DETERIORATED - ESPECIALLY AT TOP TO LEFT OF SPILLWAY AND AT LEAKING AREAS.	BRUSH GROWING IN A FEW JOINTS, GRASS GROWING IN OTHERS.
CONSTRUCTION JOINTS	N/A	
STAFF GAGE OR RECORDER	NONE	

B-13

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	24" CIP OUTSIDE OF [illegible] IN GOOD CONDITION DOWNSTREAM OF TOE.	
INTAKE STRUCTURE	Submerged.	
OUTLET STRUCTURE	None	
OUTLET CHANNEL	Access Road 75' downstream	See survey data following inspection forms
EMERGENCY GATE	1 Gate opening mechanism in scale house	Emergency drawdown valve downstream beneath conduit.

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	CRACK IN SPILLWAY/ CAPSTONE 1/4"- 1/2" WIDE (ESTIMATE) - THROUGH BLOCK THAT IS 6' FROM LEFT END	
APPROACH CHANNEL	RESERVOIR	
DISCHARGE CHANNEL	ACCESS ROAD 75' DOWNSTREAM Edges of Spillway/ Apron deteriorating.	
BRIDGE AND PIERS	NONE	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE AT SITE	
OBSERVATION WELLS		
WEIRS		
PIEZOMETERS		
OTHER	NONE AT SITE	

DOWNSTREAM CHANNEL

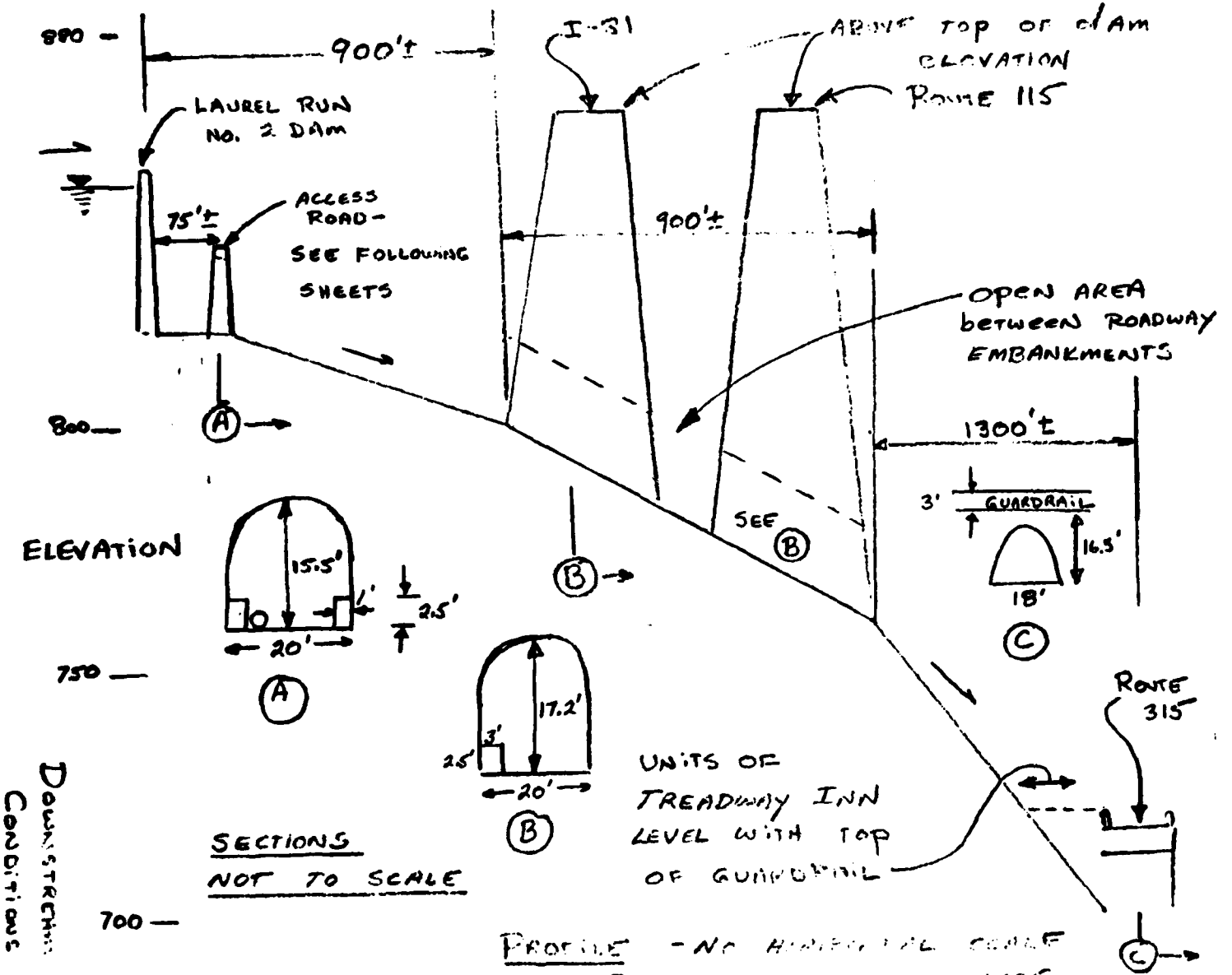
Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: **Obstructions** **Debris** **Other**	No debris - SEE SKETCH FOLLOWING INSPECTION FORMS.	
SLOPES	STEEP	
APPROXIMATE NUMBER OF HOMES AND POPULATION	SEE SKETCH FOLLOWING INSPECTION FORMS.	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	GENERALLY STEEP SOME OUTCROP	
SEDIMENTATION	NO VISIBLE OR REPORTED PROBLEMS	
WATERSHED DESCRIPTION	OVER 90% WOODED 2 RURAL COMMUNITIES AND SOME MAJOR ROADS THEREIN.	SOME MINOR IMPOUNDMENTS AND 1 DOWNSTREAM DAM IN WATERSHED.



8-9

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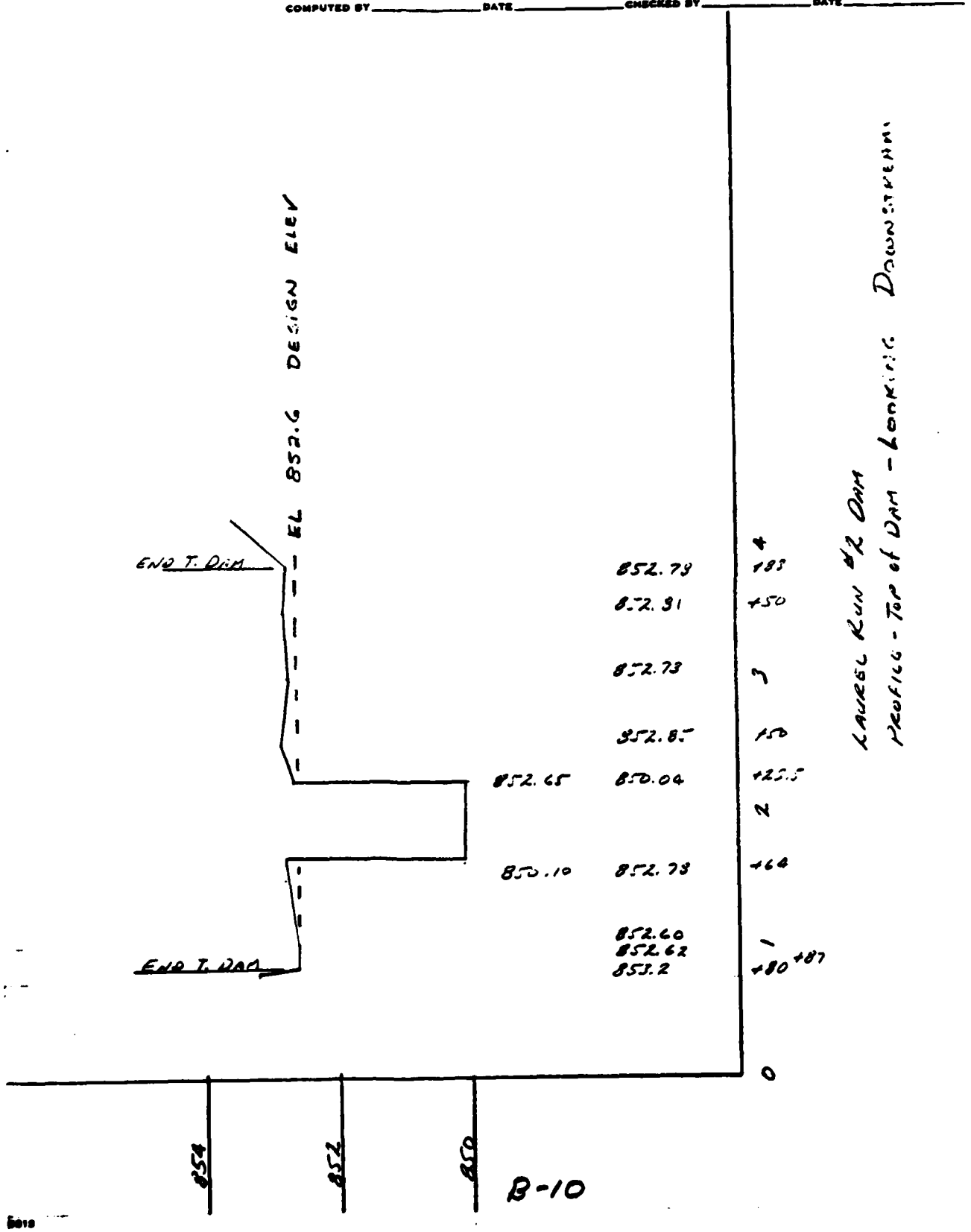

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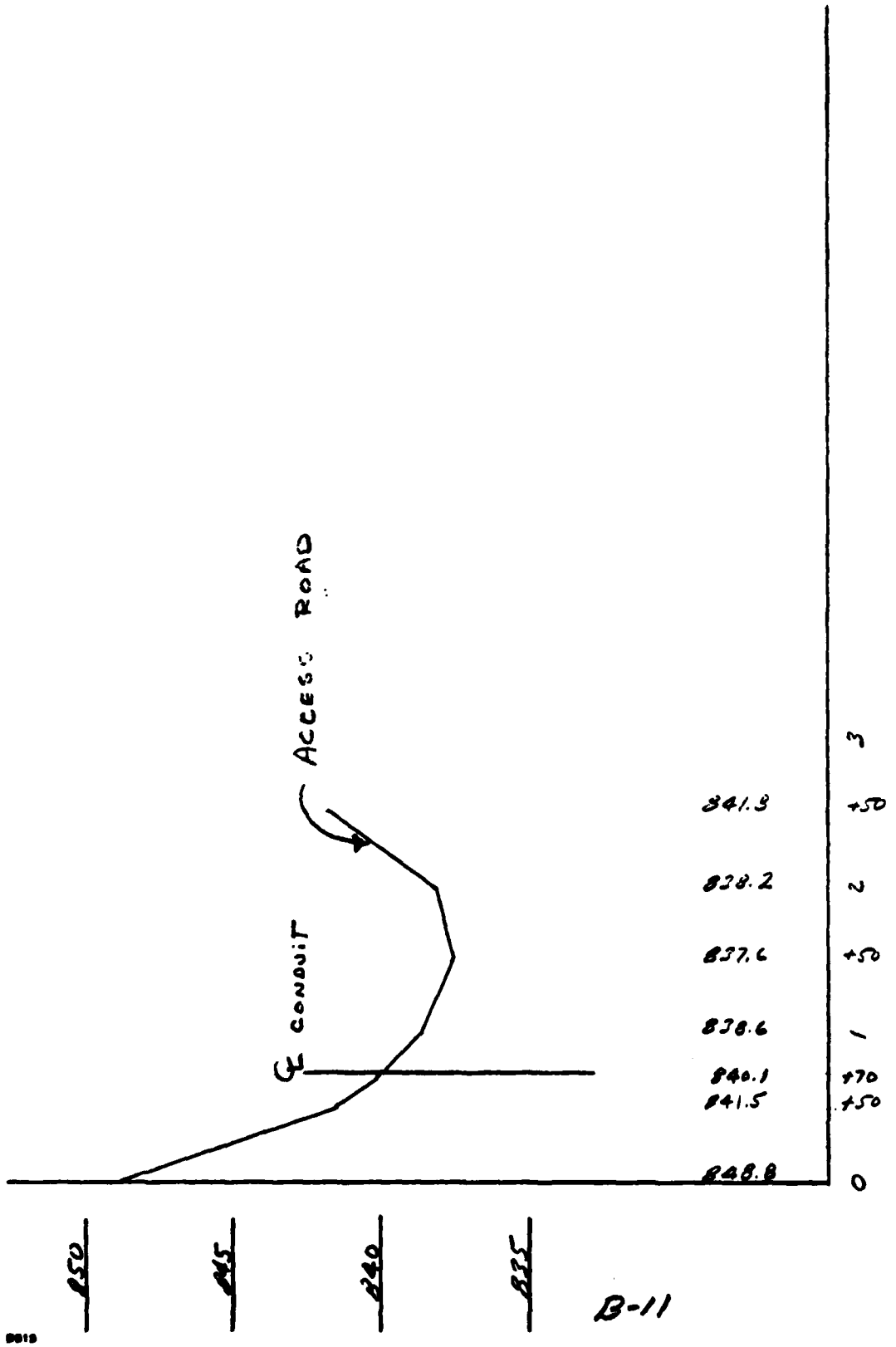
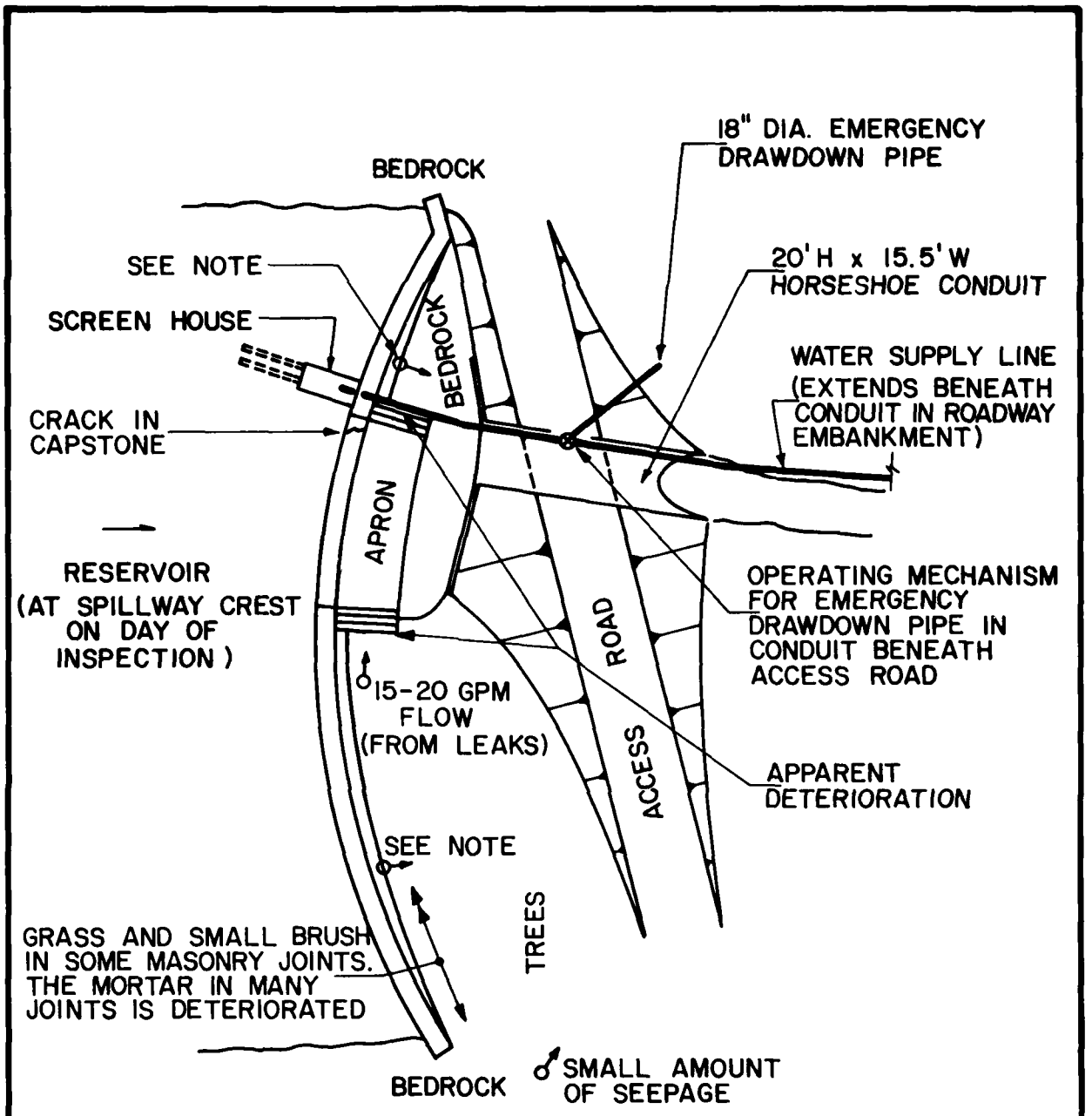


LAUREL RUN #2 DAM
PROFILE - ROAD 75'D.S
FROM DAM.

5015



NOTE:

THERE ARE MANY LEAKS IN THE MASONRY JOINTS OF THE DAM. THE LARGEST LEAK WAS ESTIMATED AT 100 GPM +.

NOT TO SCALE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAUREL RUN NO. 2 DAM

PENNSYLVANIA GAS AND WATER COMPANY

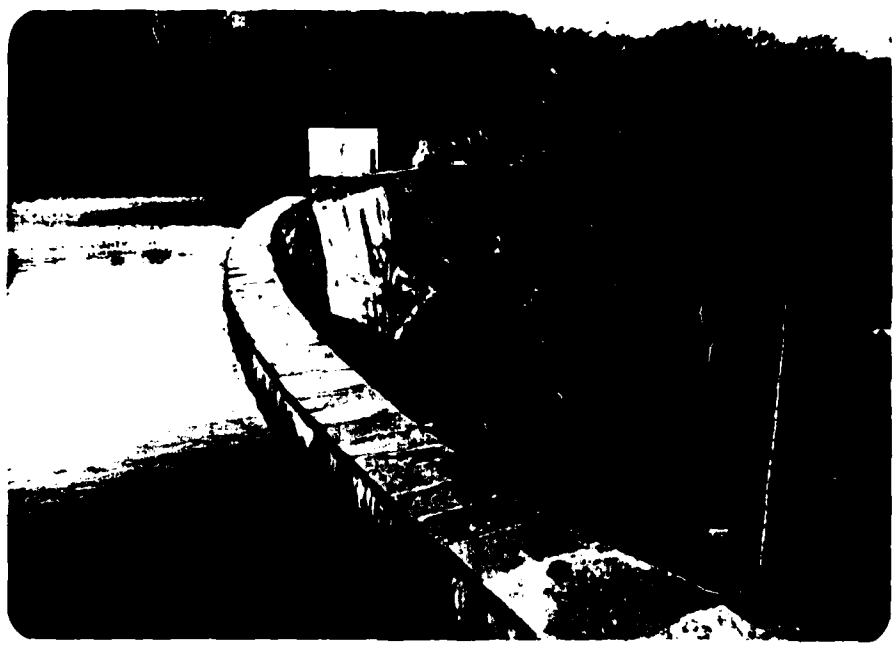
RESULT OF VISUAL INSPECTION

APRIL 1980 EXHIBIT B-1

APPENDIX C

PHOTOGRAPHS

LAUREL RUN NO. 2 DAM

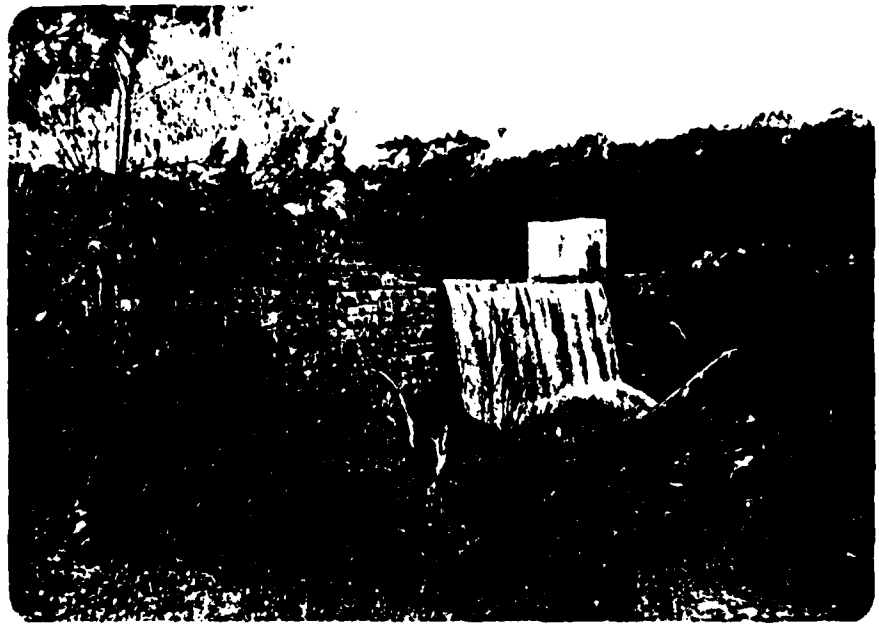


A. View From Right Abutment

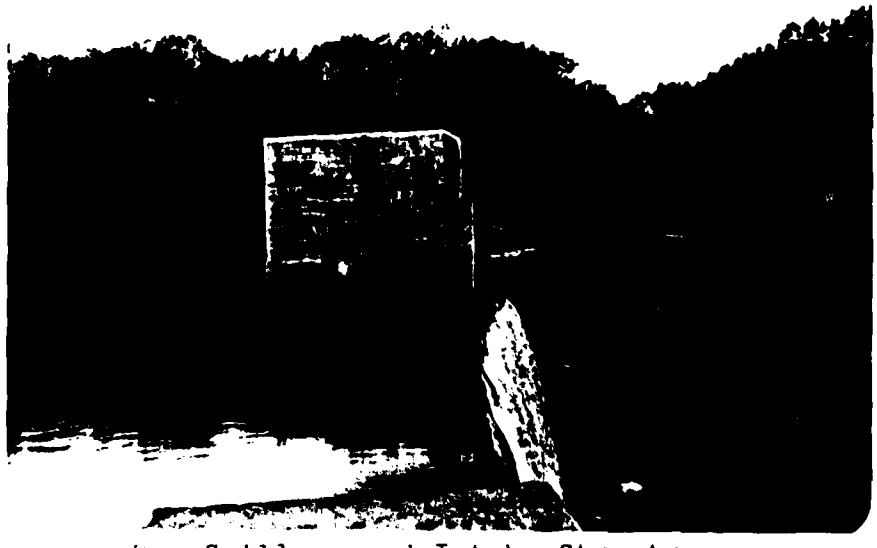
B. Right Abutment

C. Left Abutment

D. Downstream Face Near Spillway



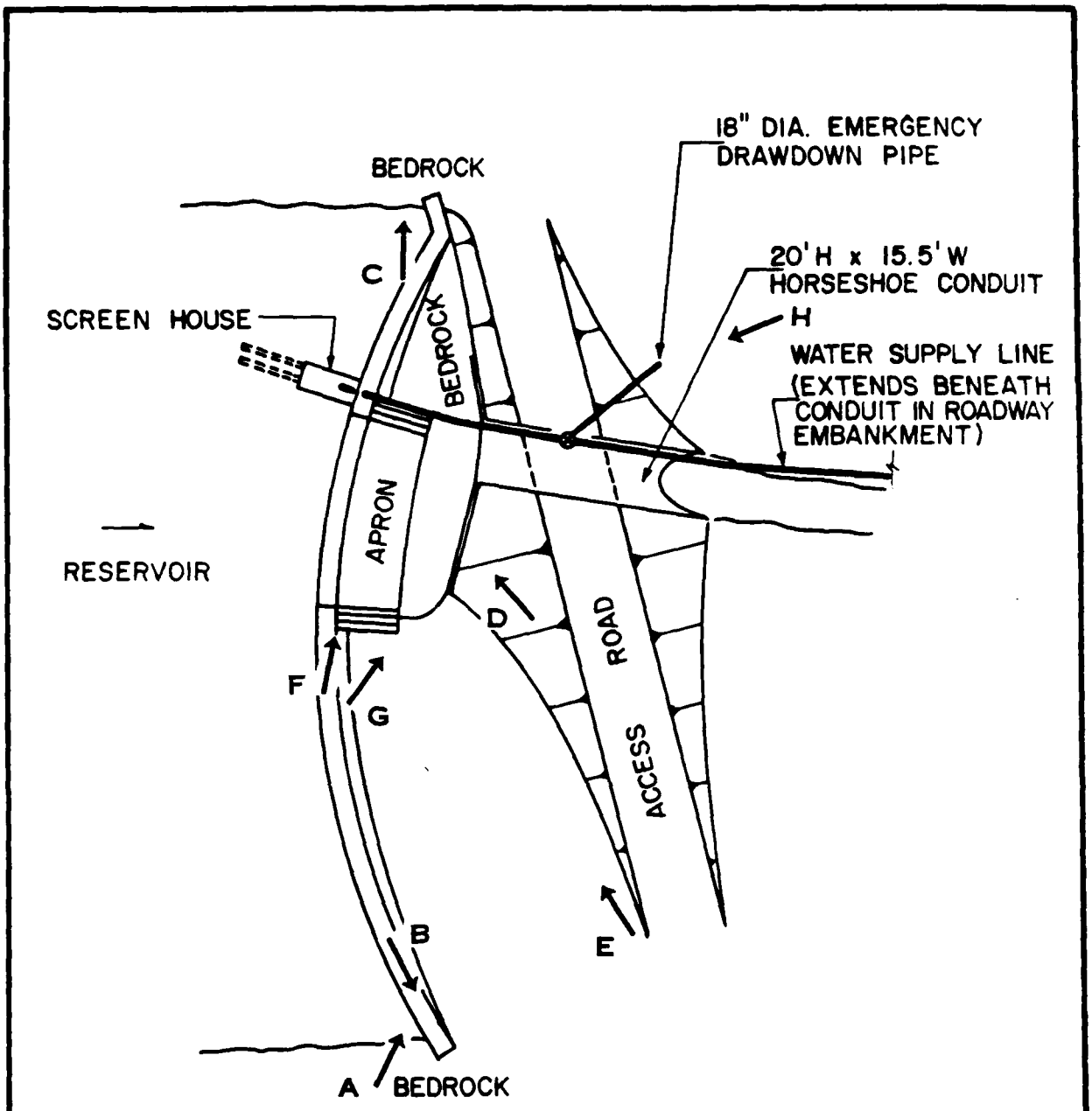
E. Spillway



F. Spillway and Intake Structure

G. Spillway Apron and Access Road

H. Outlet Works Outfall - Downstream of Access Road



NOT TO SCALE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAUREL RUN NO. 2 DAM

PENNSYLVANIA GAS
AND WATER COMPANY

GUIDE TO LOCATION OF PHOTOGRAPHS

APRIL 1980 EXHIBIT C-1

← LOCATION AND ORIENTATION OF CAMERA
A PHOTOGRAPH IDENTIFICATION LETTER

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D

HYDROLOGY AND HYDRAULICS

Spillway Capacity Rating:

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

APPENDIX D

SUSQUEHANNA River Basin
Name of Stream: LAUREL RUN
Name of Dam: LAUREL RUN NO. 2
NDI ID No.: PA-00550
DER ID No.: 40-23
Latitude: N 41° 14' 55" Longitude: W 75° 49' 05"
Top of Dam Elevation: 852.60
Streambed Elevation: 816.0 Height of Dam: 37 ft
Reservoir Storage at Top of Dam Elevation: _____ acre-ft
Size Category: SMALL
Hazard Category: HIGH (see Section 5)
Spillway Design Flood: VARIES ½PMF TO PMF
SELECT PMF

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
4 VERY SMALL IMPOUNDMENTS				
AND 1 BREACHED DAM. NONE				
OF THESE ARE CONSIDERED SIGNIFICANT				
TO ANALYSIS.				

DOWNSTREAM DAMS

NONE				

SUSQUEHANNA River Basin

Name of Stream: LAUREL RUN

Name of Dam: LAUREL RUN NO. 2

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

Sub-area	Drainage Area (square miles)	Cp (1)	Ct (2)	L miles (3)	L_{ca} miles (4)	L' miles (5)	Tp hours (6)	Map Area (7)	Plate (8)
A-1	8.48	0.30	0.95	5.53	1.70	N/A	1.86	12	F
Total	8.48								

(See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6): $Tp=C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then $Tp=C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)
RTIOR = 2.0

RAINFALL DATA:

PMF Rainfall Index= 22.15 in., 24 hr., 200 sq. mile

	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone:	N/A	N/A
Geographic Adjustment Factor:	95%	1.0
Revised Index Rainfall:	21.0"	N/A

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	118
12 hours	127
24 hours	136
48 hours	142
72 hours	145
96 hours	N/A

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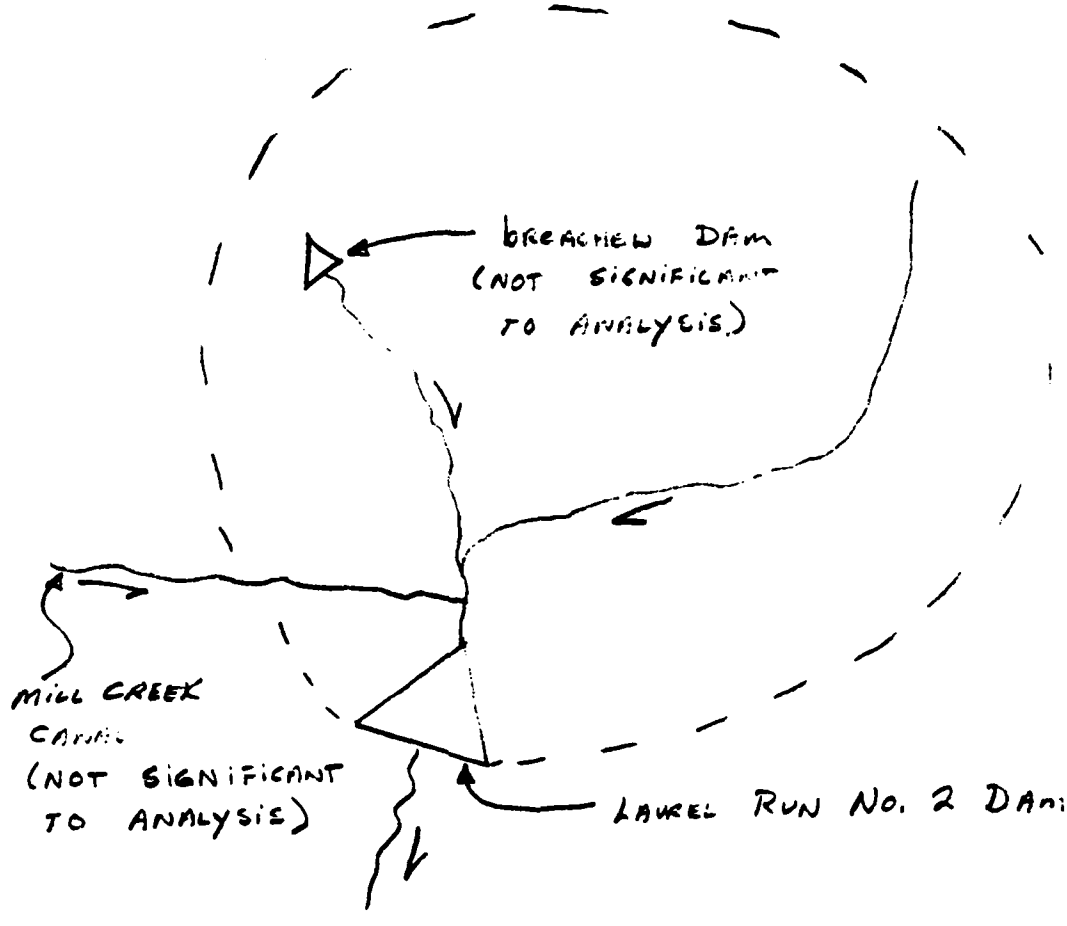

SKETCH
OF
SYSTEM

Data for Dam at Outlet of Subarea A-1 (See sketch on Sheet D-4)

Name of Dam: LAUREL RUN No. 2

STORAGE DATA:

Elevation		Area (acres)		Storage million gals	Storage acre-ft		Remarks
791.7	=ELEVO*	0		0	0		
850.10	=ELEV1	5.5	=A1	35	107	=S1	OWNER DATA
852.6		6.1			122		
860		8.3	**				
880		13.8	**				

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is NEGL. percent of subarea watershed.

BREACH DATA: Not Used

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-1

Name of Dam: LAUREL RUN No. 2

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	852.6	SAME
Spillway Crest Elevation	850.10	
Spillway Head Available (ft)	2.5	
Type Spillway	PART OF DAM	
"C" Value - Spillway	3.3	
Crest Length - Spillway (ft)	61	
Spillway Peak Discharge (cfs)	796	
Auxiliary Spillway Crest Elev.	N/A	
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)	N/A	
Combined Spillway Discharge (cfs)	≈ 800	

Spillway Rating Curve: $Q = C L H^{3/2}$

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1 Water Supply Pipe	Outlet 2 Blowoff Pipe		Outlet 3 1+2 combined
Invert of Outlet	N/A	820.0±		
Invert of Inlet	821.0	N/A		
Type	CIP	CIP		
Diameter (ft) = D	2.0	1.5		
Length (ft) = L	98'	19		
Area (sq. ft) = A	3.14	1.77		1.77
N	.014	.014		
K Entrance	0.5	N/A		
K Exit	N/A	1.0		
K Friction=$29.1N^2L/R^{4/3}$	1.41	0.4		
Sum of K	$1.91 \times \left(\frac{1.77}{3.14}\right)^2 +$	1.4	=	2.01
$(1/K)^{0.5} = C$				0.71
Maximum Head (ft) = HM				31.6
$Q = CA\sqrt{2g(HM)}$ (cfs)				57
Q Combined (cfs)			≈	60

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FOR _____

COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

Selected Computer Output

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  17 JAN 80
**********
    1                 A1                                NATIONAL DAM INSPECTION PROGRAM
    2                 A2                                        LAUREL RUN
    3                 A3                                LAUREL RUN NO. 2 DAM
    4                 B     300         0        15         0         0         0         0         0        -4         0
    5                 B1      5
    6                 J       1         9         1
    7                 J1      1        .5        .6        .5        .4        .3        .2        .1       .05
    8                 K       0         1                                                  1
    9                 K1          INFLOW TO RESERVOIR
   10                 M       1         1      8.48                 8.48                                      1
   11                 P                 21       118       127       136       142       145
   12                 T                                                                  1       .05
   13                 W    1.86      0.30
   14                 X    -1.5      -.05       2.0
   15                 K       1         1                                                  1
   16                 K1          ROUTE THROUGH DAM
   17                 Y                                     1
   18                 Y1      1                                                       -850.1
   19                 SA      0       5.5       8.3      13.8
   20                 SE  791.7     850.1       860       880
   21                 SS  850.1        61       3.3       1.5
   22                 SD  852.6       2.7       1.5       240
   23                 K      99
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1 1.00	RATIO 2 .80	RATIO 3 .60	RATIO 4 .50	RATIO 5 .40	RATIO 6 .30	RATIO 7 .20	RATIO 8 .10	RATIO 9 .05
HYDROGRAPH AT	1	8.48	1	13070.	10456.	7842.	6535.	5228.	3921.	2614.	1307.	654.
	(	21.96)	(	370.11)(	296.09)(	222.07)(	185.06)(	148.05)(	111.03)(	74.02)(	37.01)(	18.51)
ROUTED TO	1	8.48	1	13069.	10455.	7841.	6534.	5227.	3921.	2614.	1307.	653.
	(	21.96)	(	370.08)(	296.06)(	222.04)(	185.03)(	148.03)(	111.02)(	74.01)(	37.01)(	18.48)

D-9

SUMMARY OF DAM SAFETY ANALYSIS

LAUREL RUN No. 2 DAM

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	850.10	850.10	852.60
STORAGE	107.	107.	122.
OUTFLOW	0.	0.	796.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	859.15	5.55	160.	13069.	21.25	42.00	0.00
.80	857.20	4.60	154.	10455.	19.50	42.00	0.00
.60	856.35	3.75	147.	7841.	17.75	42.00	0.00
.50	855.83	3.23	143.	6534.	16.75	42.00	0.00
.40	855.28	2.68	139.	5227.	15.25	42.00	0.00
.30	854.68	2.08	135.	3921.	13.25	42.00	0.00
.20	853.99	1.39	130.	2614.	10.50	42.00	0.00
.10	853.13	.53	125.	1307.	5.25	42.00	0.00
.05	852.29	0.00	120.	653.	0.00	42.25	0.00

01-0

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____
SHEET NO. ____ OF ____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

Summary of Pertinent Results

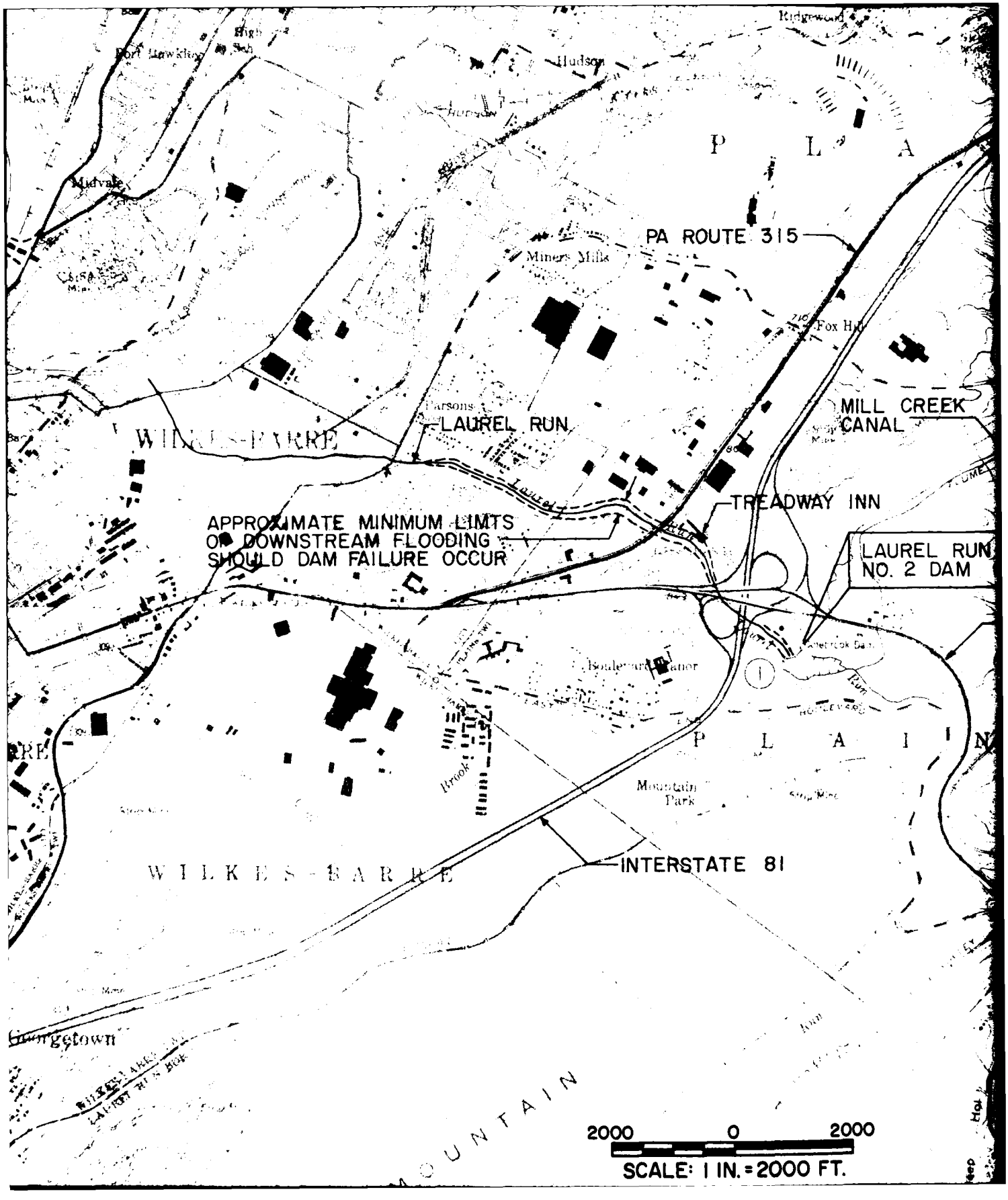
PMF Rainfall = 24.36"

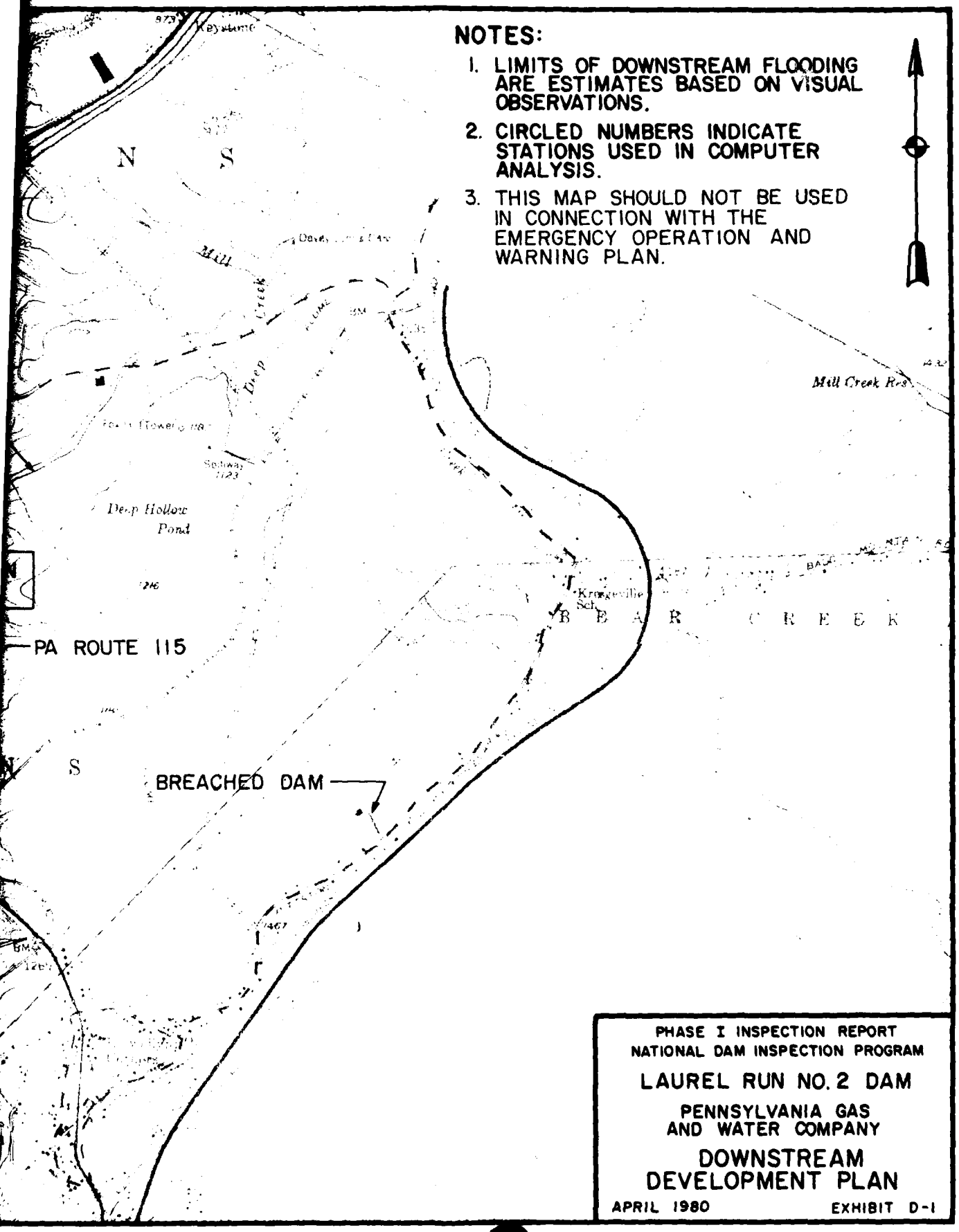
	PMF	½ PMF
Runoff (inches)	21.79	10.90
Laurel Run No. 2 Dam		
Peak Inflow (cfs)	13,070	6,535
Peak Outflow (cfs)	13,069	6,534
Depth of Overtopping (ft)	5.55	3.23
Duration of Overtopping (ft)	21.25	16.75

8913

APPENDIX E

PLATES


PA ROUTE 315
MILL CREEK CANAL
LAUREL RUN
TREADWAY INN
APPROXIMATE MINIMUM LIMTS OF DOWNSTREAM FLOODING SHOULD DAM FAILURE OCCUR
LAUREL RUN NO. 2 DAM
INTERSTATE 81
2000 0 2000
SCALE: 1 IN. = 2000 FT.



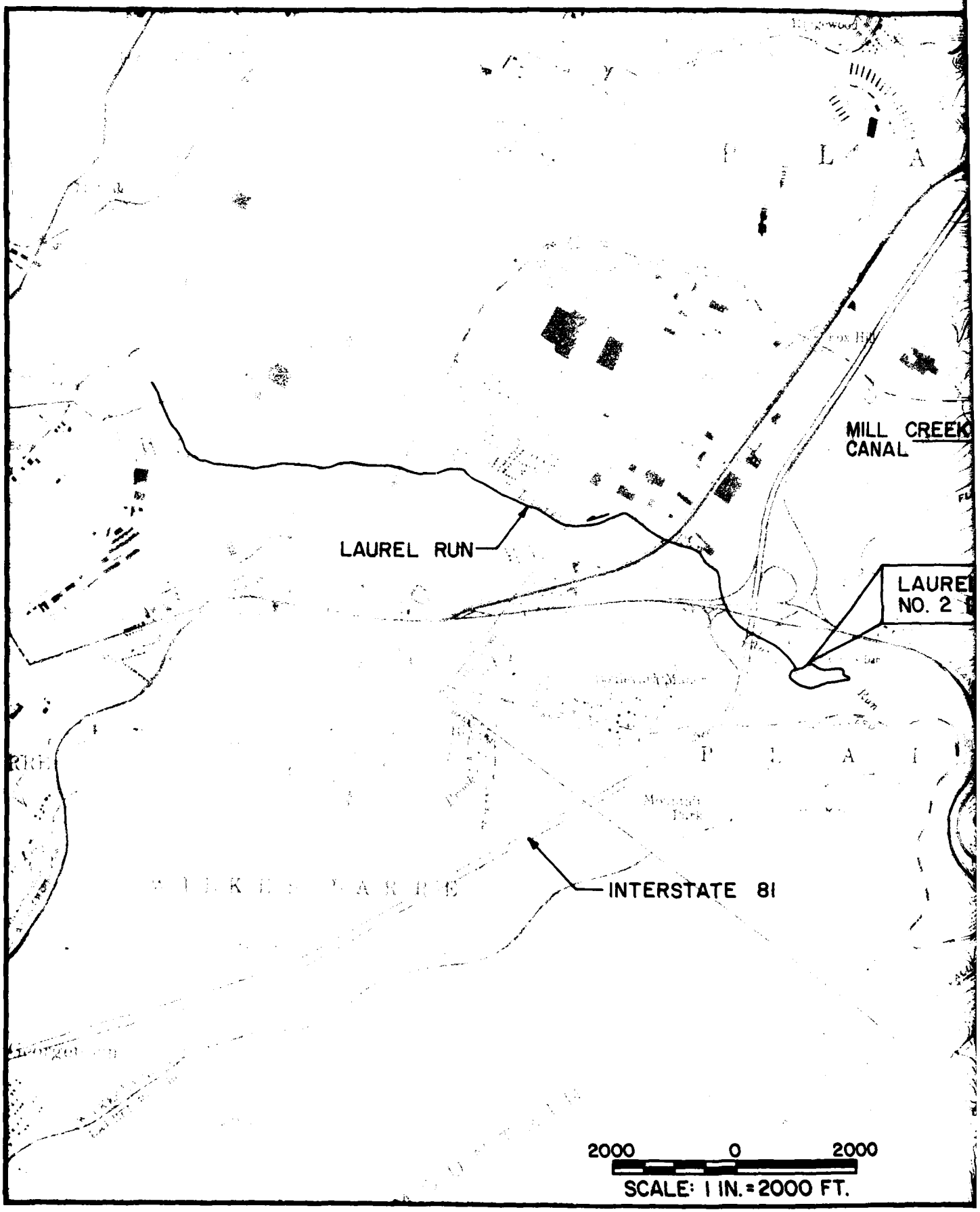
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

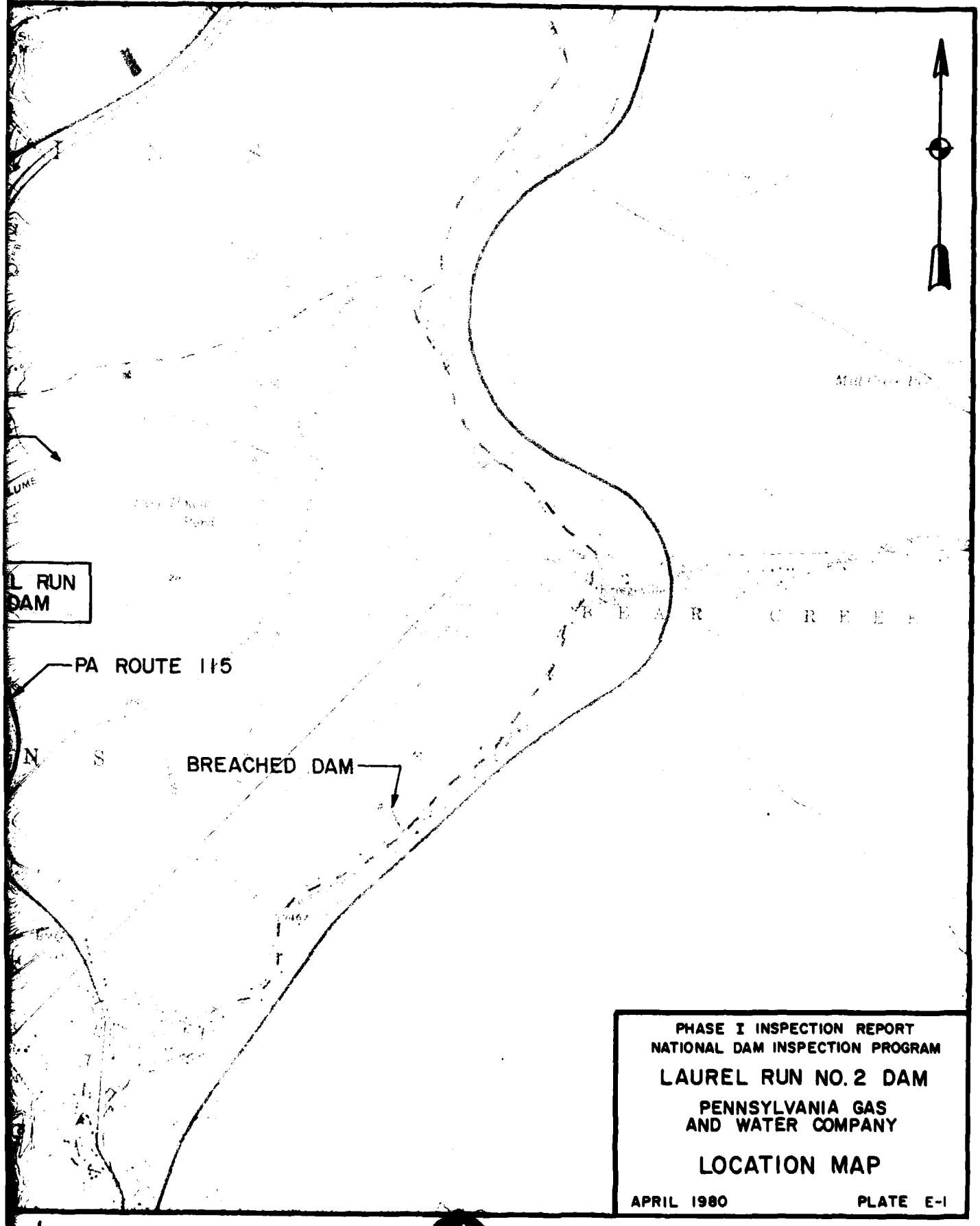
LAUREL RUN NO. 2 DAM

PENNSYLVANIA GAS
AND WATER COMPANY

DOWNSTREAM DEVELOPMENT PLAN

APRIL 1980 EXHIBIT D-1


MILL CREEK
CANAL
LAUREL RUN
LAUREL
NO. 2
INTERSTATE 81
2000 0 2000
SCALE: 1 IN. = 2000 FT.



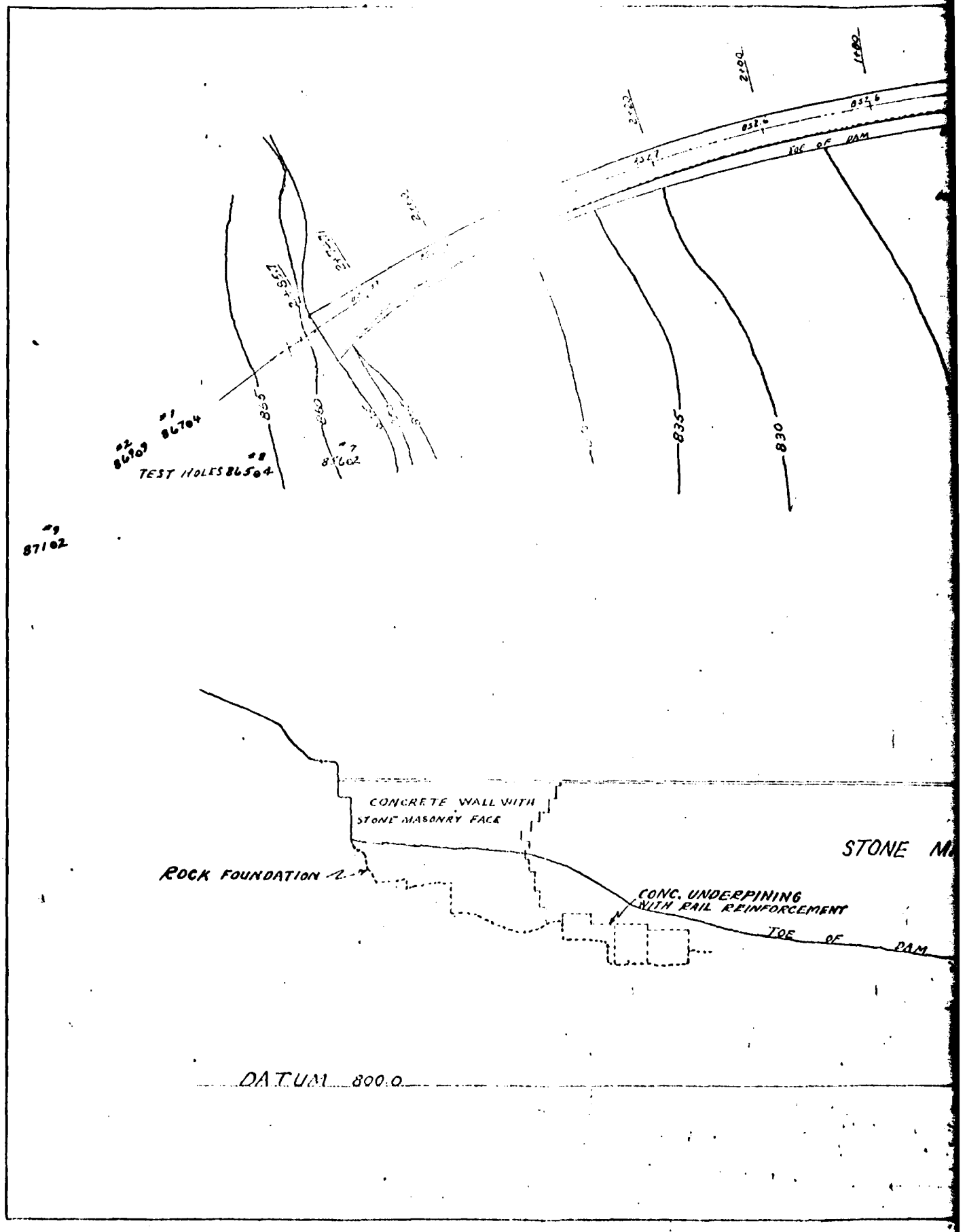
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

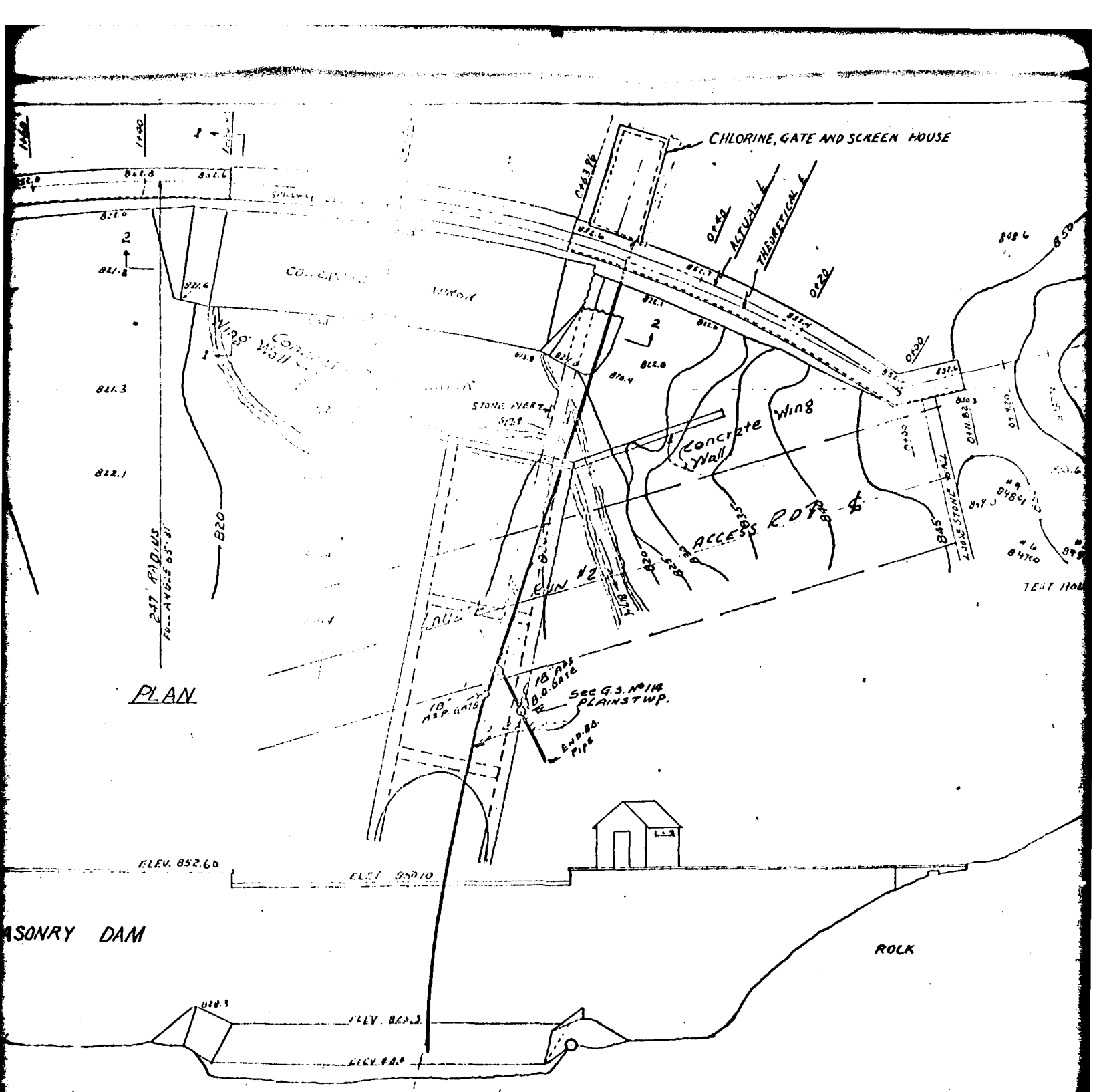
LAUREL RUN NO. 2 DAM

PENNSYLVANIA GAS
AND WATER COMPANY

LOCATION MAP

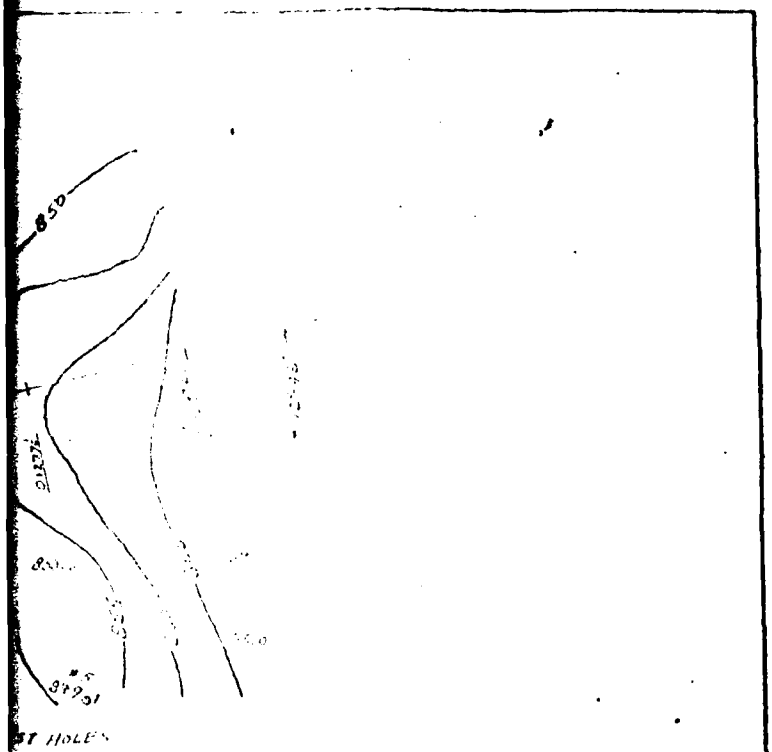
APRIL 1980 PLATE E-1


TOE OF DAM
TEST HOLES 86504
#1 86704
#2 86709
#7 87602
#8
#9 87102
#10 87403
#3 87202
5'
CONCRETE WALL WITH STONE MASONRY FACE
ROCK FOUNDATION
CONC. UNDERPINING WITH RAIL REINFORCEMENT
TOE OF DAM
DATUM 800.0



FRONT ELEVATION

REVISED 1-19-1972
FOR TEST HOLE DATA SEE FIELD NOTES INDEX No.
SEE DWG. D-716-P FOR DETAILS OF IMPROVEM
COMPLETED IN 1930



CURVE DATA

TRANSIT SET ON STA. 0+00 SIGHT
DIRECT TO STA. 2+74.71

STATION		ANGLE
2+74.71		0°-00'-00"
2+60	RT.	1°-45'-00"
2+40	"	4°-06'-45"
2+20	"	6°-23'-45"
2+00	"	8°-42'-45"
1+80	"	11°-03'-45"
1+60	"	13°-28'-30"
1+40	"	15°-43'-30"
1+24.96	"	17°-37'-15"
0+94.46	"	21°-21'-30"
0+63.96	"	25°-29'-30"
0+40	"	29°-18'-00"
0+20	"	32°-20'-00"

RECORD DRAWING

SCRANTON-SPRING BROOK WATER SERVICE CO.
WILKES BARRE, PA.

LAUREL RUN No.2 DAM

LUZERNE CO. PLAINS Twp., PENNA.

DRAWN BY J.H.	DATE MAR. 2,-50	D-716-111
TRACED BY J.H.	SCALE 1"=20.'	
CHECKED BY	APP'D BY	

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

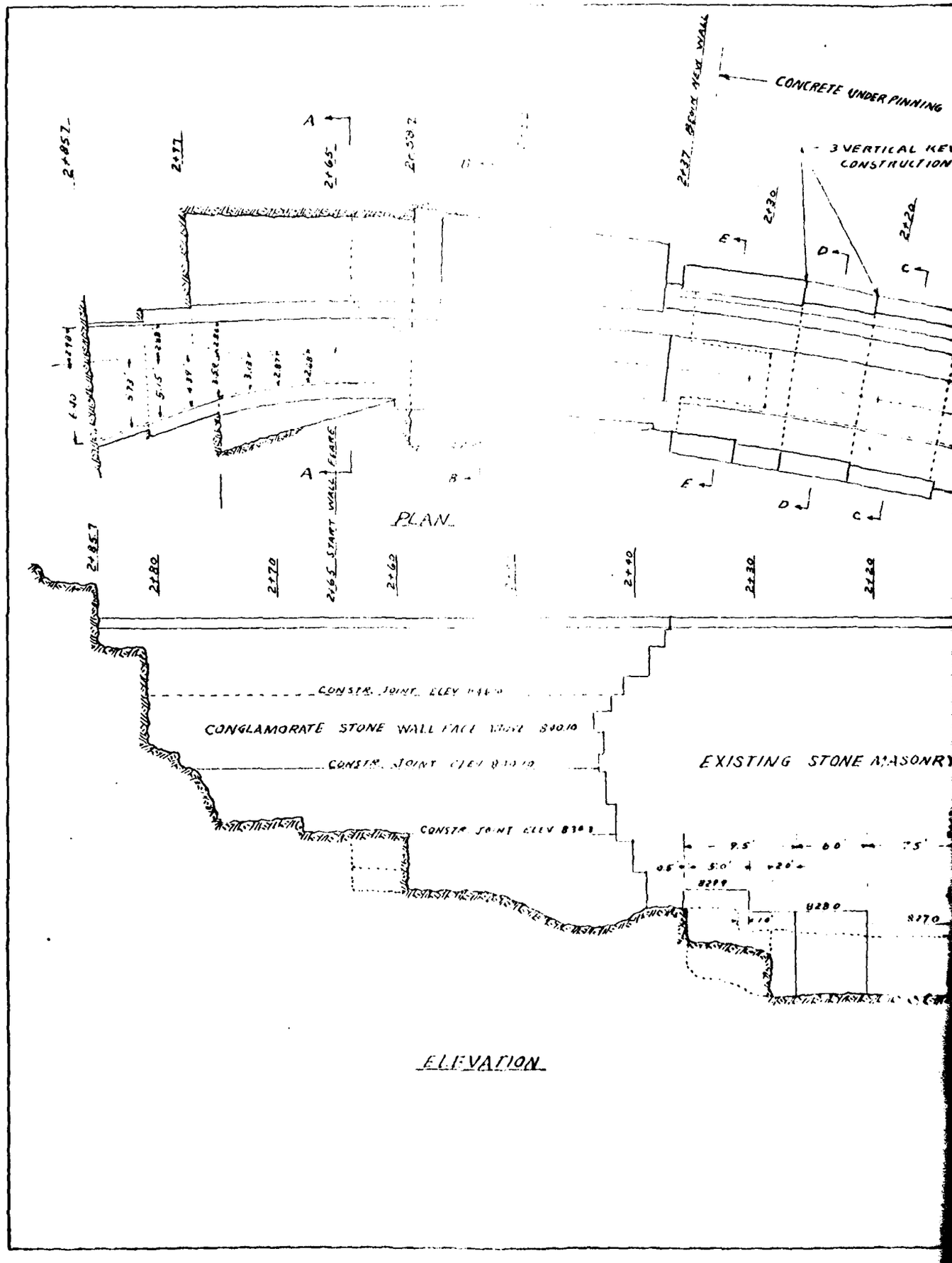
LAUREL RUN NO. 2 DAM

PENNSYLVANIA GAS
AND WATER COMPANY

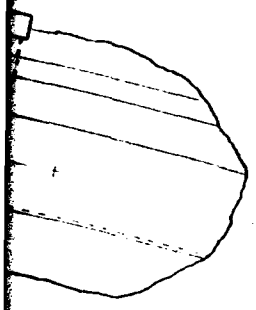
PLAN AND PROFILE

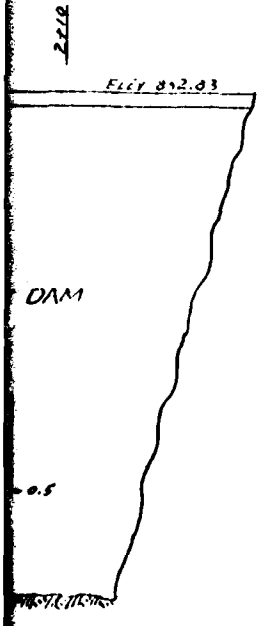
APRIL 1980 PLATE E-2

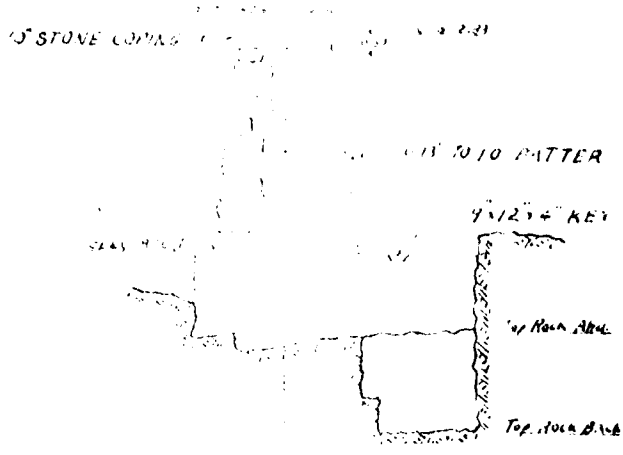
B


CONCRETE UNDER PINNING
3 VERTICAL KEY CONSTRUCTION
2+85.7
2+37
2+65
2+38.2
2+37 BEGIN NEW WALL
2+30
2+20
A
B
C
D
E
2+65 START WALL FLARE
PLAN
2+80
2+70
2+62
2+40
2+30
2+20
CONSTR. JOINT ELEV 844.0
CONGLAMORATE STONE WALL FACE ABOVE ELEV 840.0
CONSTR. JOINT ELEV 838.0
EXISTING STONE MASONRY
CONSTR JOINT ELEV 834.5
9.5'
6.0'
7.5'
5.0'
20'
8299
8280
8270
ELEVATION

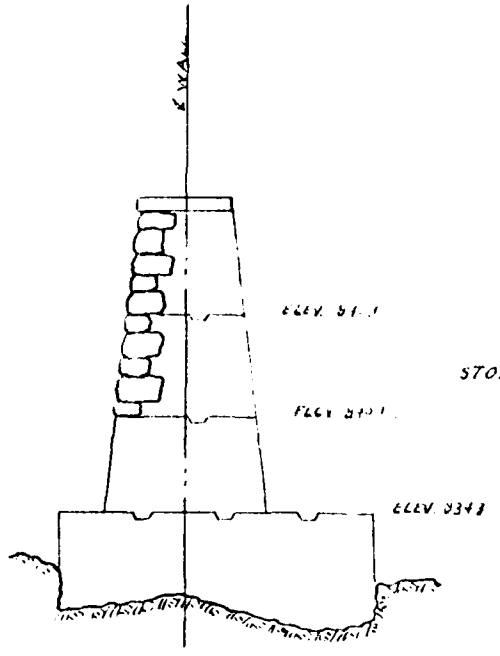
& IN EACH JOINTS



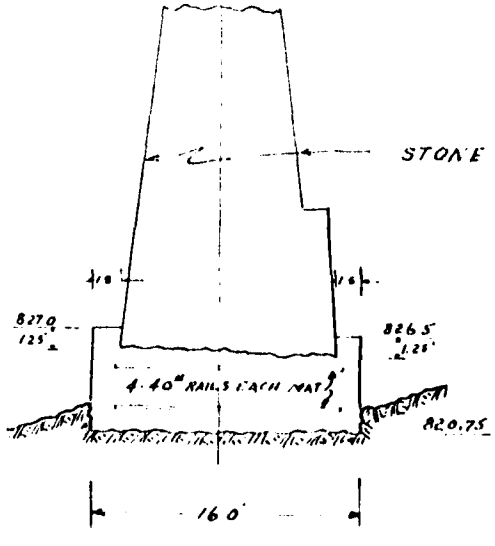




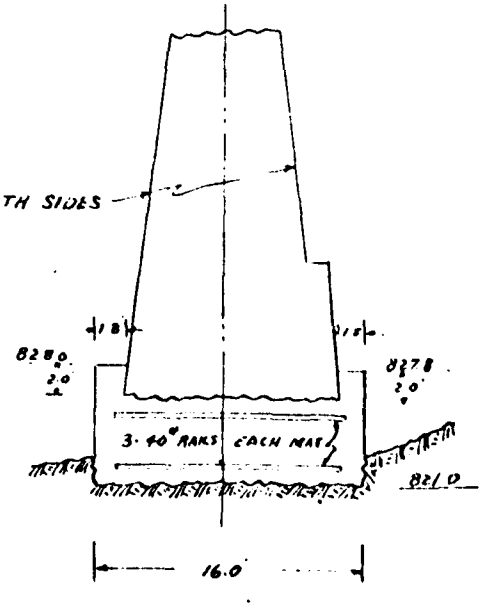
SECTION A-A
STA 2+63.75



SECTION B-B
STA 2+52.5

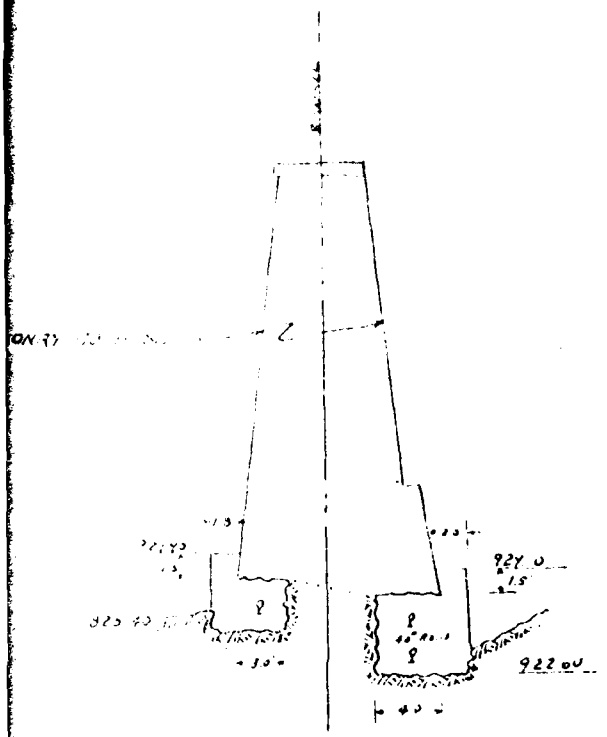


SECTION C-C



SECTION D-D

SEE DWG D-716-m FOR PLAN OF DAM



SECTION E-E

RECORD DRAWING

SCRANTON-SPRING BROOK WATER SERVICE CO.
WILKES-BARRE, PA
IMPROVEMENTS TO
LAUREL RUN No. 2 DAM
1950-S.P. 147-1 W.O. 51676-08

DRAWN BY J.H. TRACED BY J.H. CHECKED BY	DATE 2-22-52 SCALE 1" = 10.0' APPVD BY	D-716-p

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

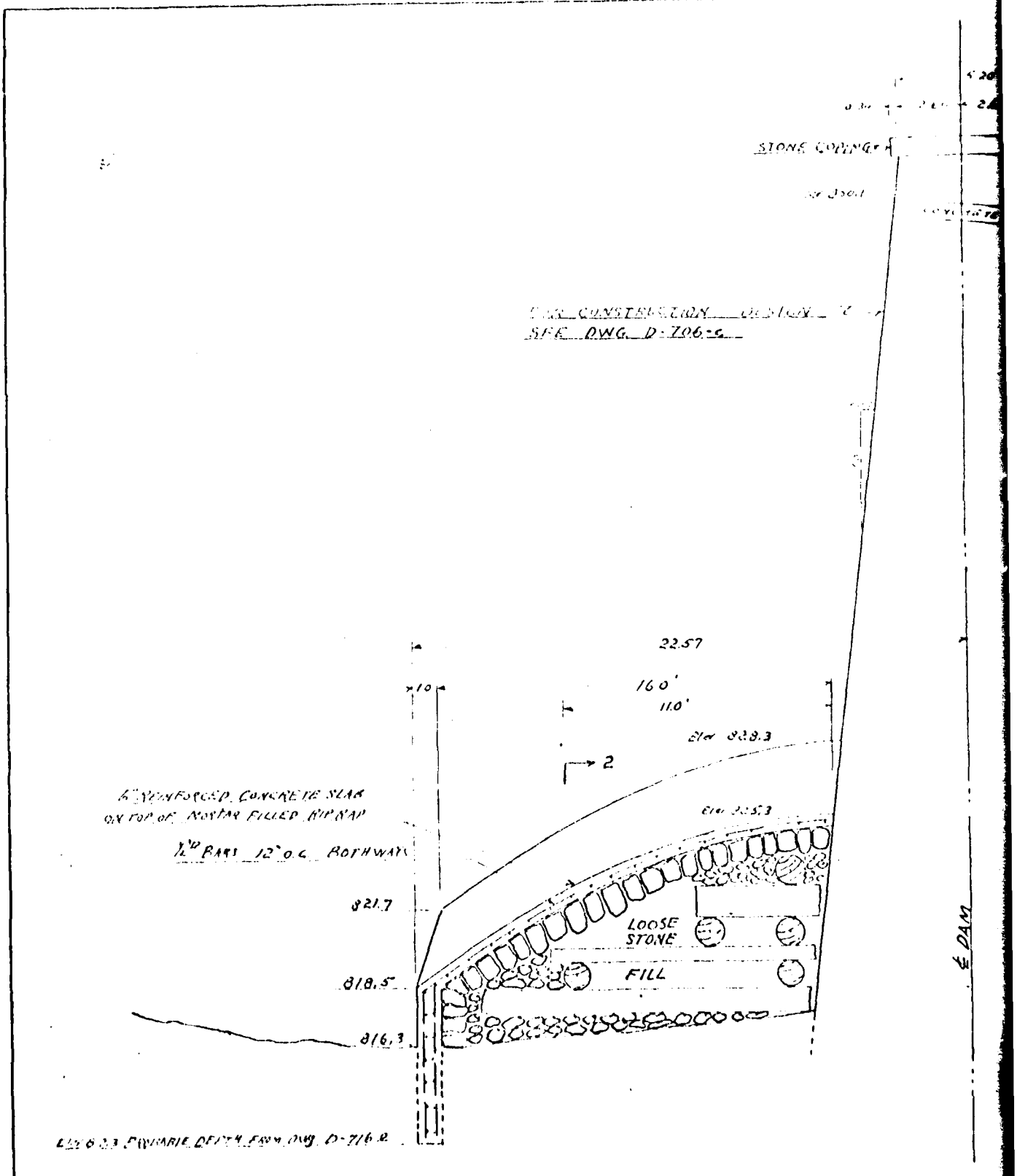
LAUREL RUN NO. 2 DAM

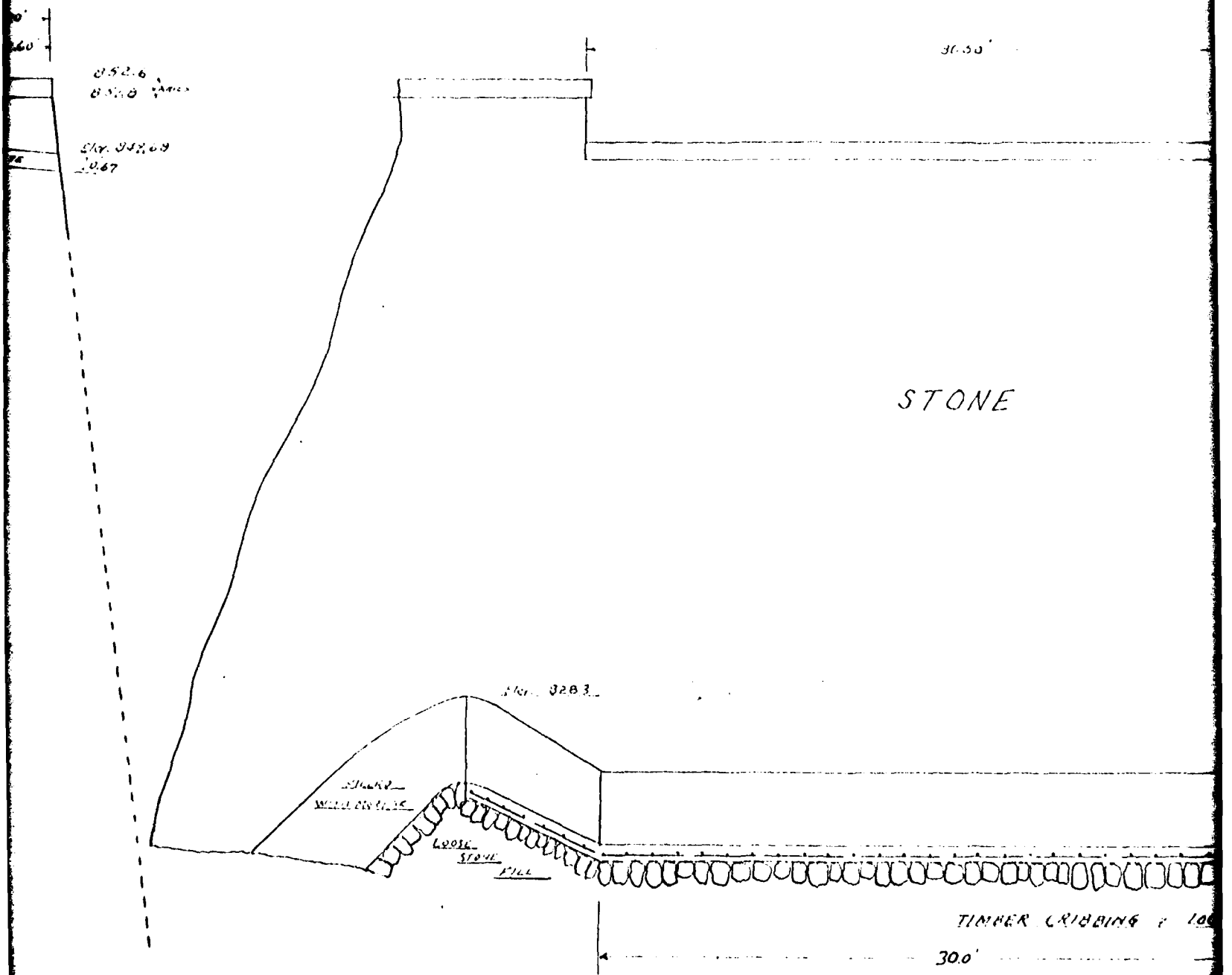
PENNSYLVANIA GAS
AND WATER COMPANY

RIGHT ABUTMENT

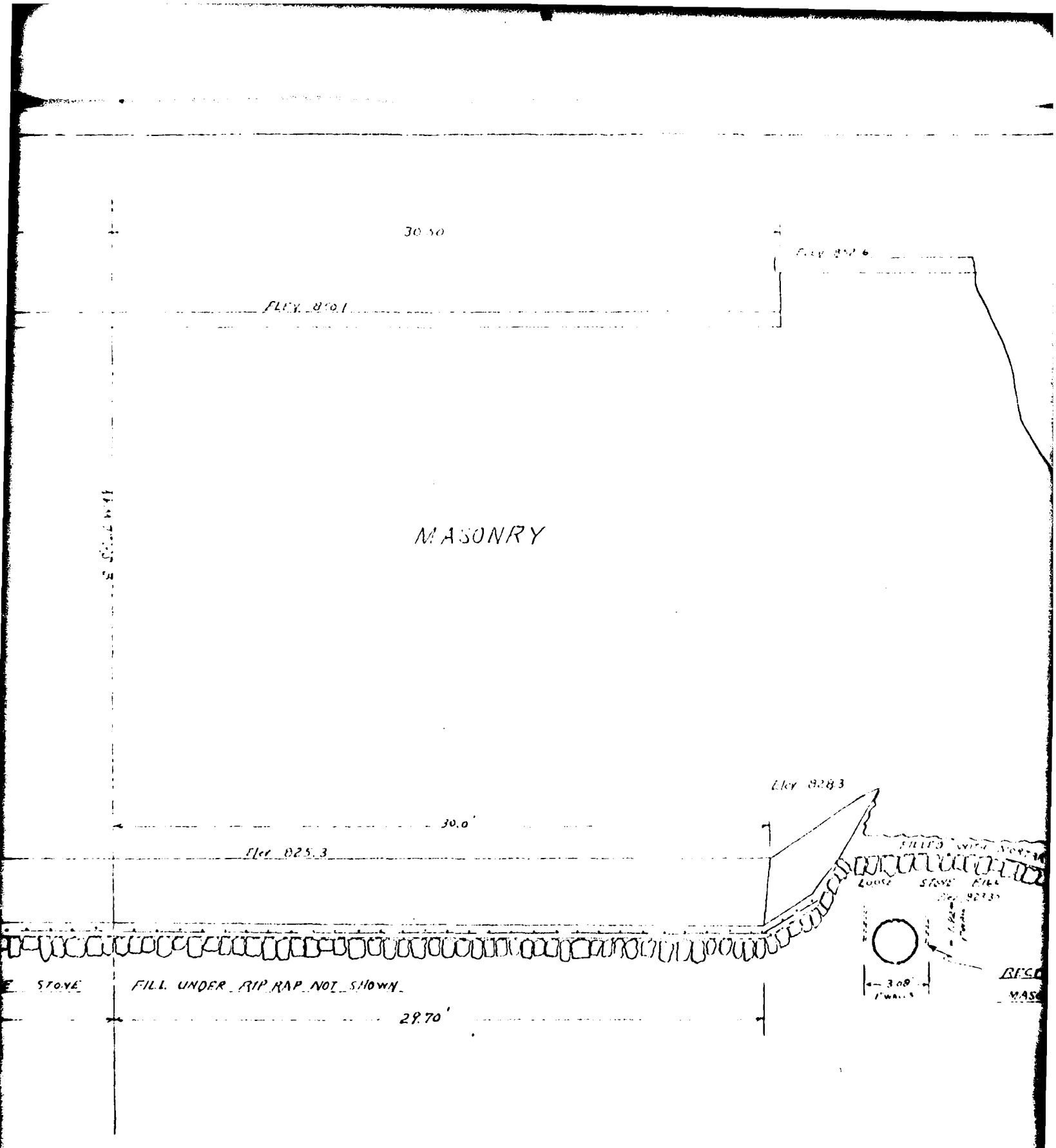
APRIL 1980 PLATE E-3

3

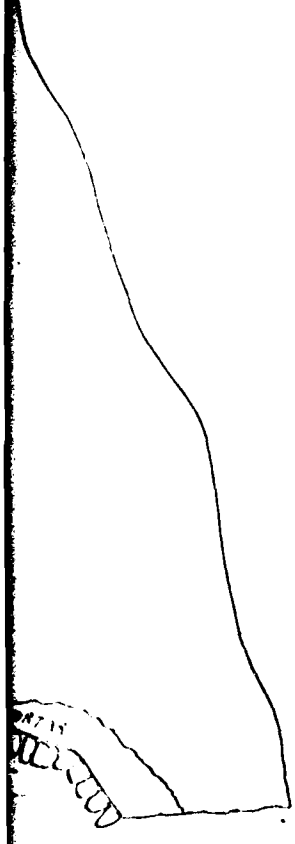

STONE COPING
FOR CONSTRUCTION JOINT
SEE DWG. D-706-6
22.57
16.0'
11.0'
Elev 838.3
2
Elev 833.3
6" REINFORCED CONCRETE SLAB
ON TOP OF MORTAR FILLED RIP RAP
½" BARS 12" O.C. BOTHWAYS
821.7
LOOSE
STONE
FILL
818.5
816.3
DATUM 810
TYPICAL SEC
DAM



ION 1-1


30.50
Elev 827.6
Elev 810.1
MASONRY
Elev 828.3
30.0'
Elev 825.3
FILL UNDER RIP RAP NOT SHOWN
28.70'
3.08'

SECTION 2-2



RECORD

SCRANTON-SPRING
W'

LAU

LUZERNE

DRAWN BY J.H	
TRACED BY J.H	SCALE
CHECKED BY	APPVD

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

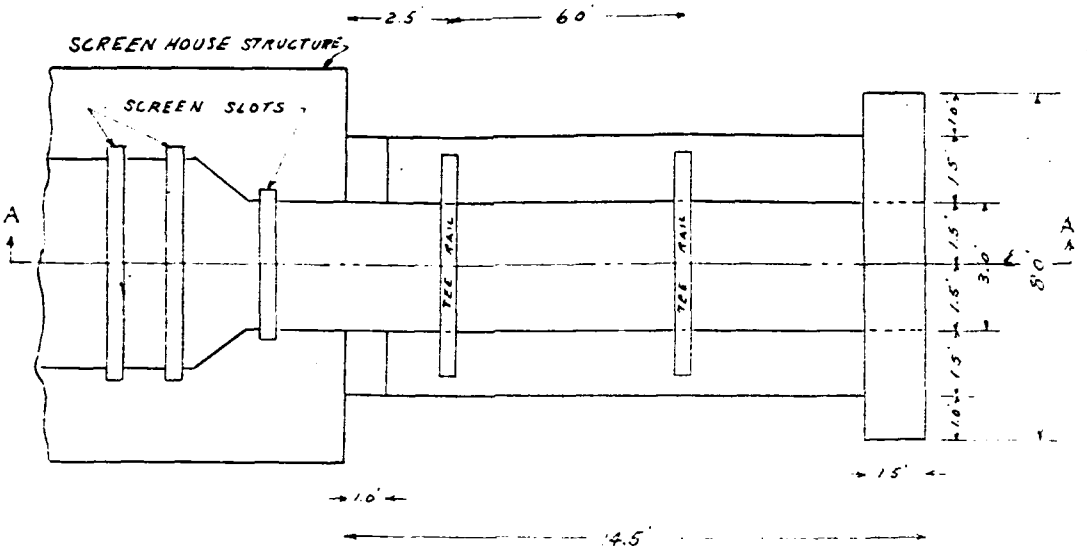
LAUREL RUN NO. 2 DAM

PENNSYLVANIA GAS
AND WATER COMPANY

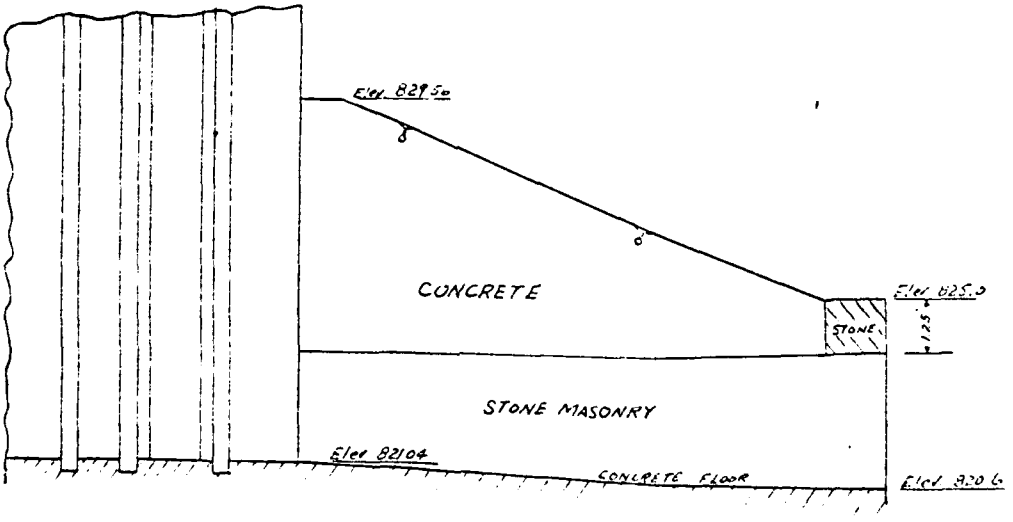
SPILLWAY APRON

APRIL 1980 PLATE E-4

4



PLAN



SECTION A-A

RECORD DRAWING

SCRANTON-SPRING BROOK WATER SERVICE CO.

WILKES-BARRE, PA.

RETAINING WALLS OF INTAKE CHAMBER

LAUREL RUN No. 2 RESERVOIR

LUZERNE CO. PLAINS Twp., PENNA.

DRAWN BY J.H TRACED BY J.H CHECKED BY	DATE 2-25-80 SCALE 1/4"=1'0" APPVD. BY	D-716-8

...HOUSE - SEE DWG D-716-8

PHASE 2
NATIONAL D
LAUREL
PENN
AND W
INTAK
APRIL 1980

INSPECTION REPORT
AM INSPECTION PROGRAM

RUN NO. 2 DAM

SYLVANIA GAS
ATER COMPANY

E STRUCTURE

PLATE E-5

2

APPENDIX F

GEOLOGY

LAUREL RUN NO. 2 DAM

APPENDIX F

GEOLOGY

Laurel Run No. 2 Dam is located in Luzerne County and lies within the Valley and Ridge Province. The Lackawanna Syncline is the most important structural feature in this section of northeastern Pennsylvania. It is a broad canoe-shaped downwarp that trends northeast and southwest from Orson to Orangeville. The rim rocks are of the Pottsville and Pocono Formations; they have dips that are usually 20° or less and form a simple syncline. The core rock is of the Llewellyn Formation; it is folded into a series of minor anticlines and synclines that trend N 70°E. Rock to both the northwest and southeast of the Lackawanna Syncline is of the Appalachian Plateau Province and is usually horizontally-bedded.

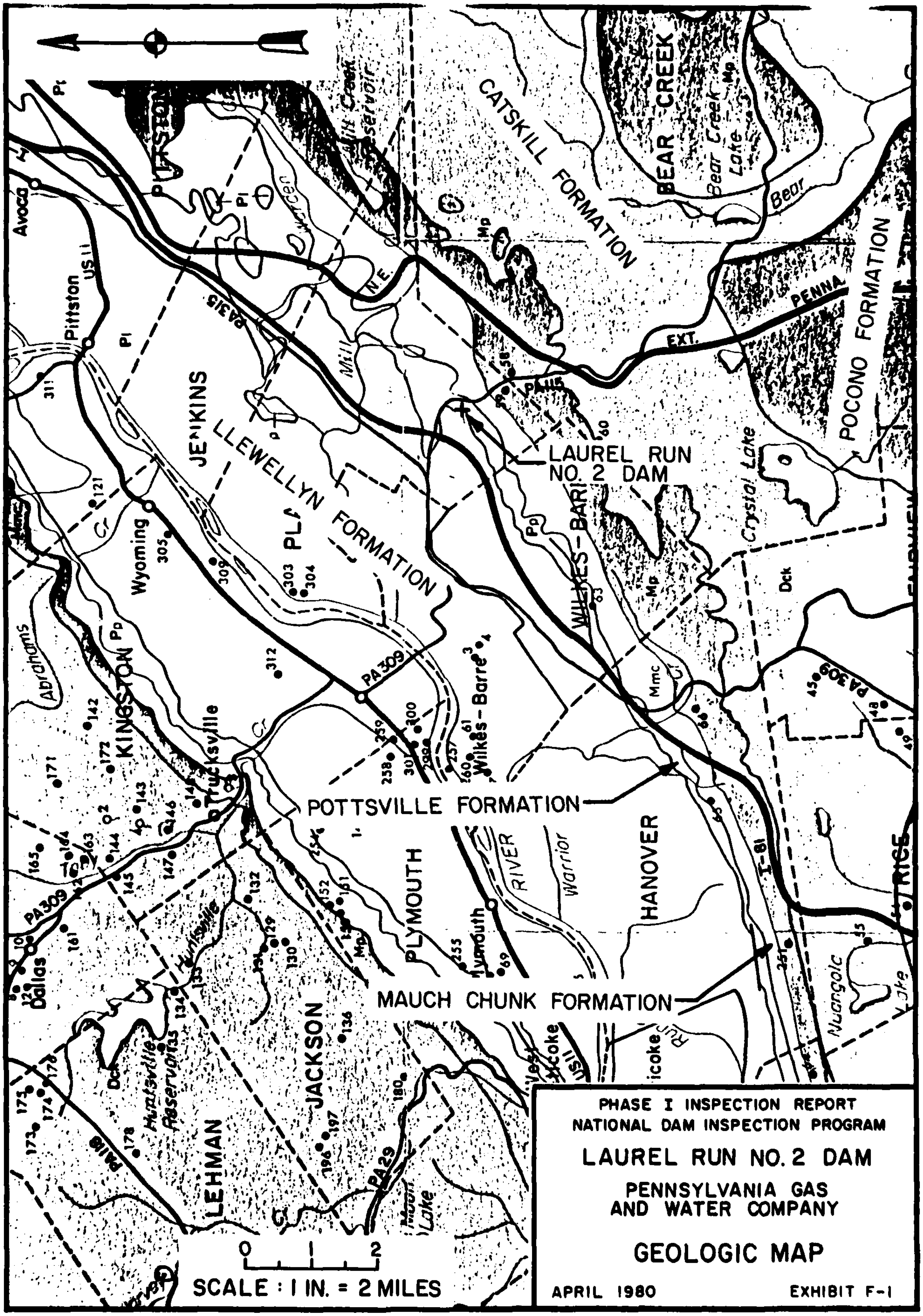
Bedrock units of the Lackawanna syncline are the lithified sediments of deltaic, fluvial, and swamp environments. The sediments are of the Mississippian and the Pennsylvanian Periods. The bedrock units include sandstones, conglomerates, and shales of the Pocono Formation; red shales of the Mauch Chunk Formation; and sandstones, conglomerates, shales, and coals of the Pottsville and Llewellyn Formations.

Laurel Run No. 2 Dam is underlain by rocks of the Pottsville Formation. This formation primarily consists of a hard sandstone and conglomerate with some shales and a few thin coal beds. Sandstones in this unit are generally very micaceous and range from fine- to coarse-grained. The conglomerates are white and contain rounded to sub-angular quartz pebbles set in a medium- to coarse-grained, quartz-sand matrix. Shales occur primarily as non-fissile to sub-fissile thin beds.

Bedding of the rock is generally well-developed and ranges from fractions of an inch in shales to several feet in the sandstones and conglomerates. Crossbedding is common in the sandstones. The sandstones and conglomerates associated with the Pottsville Formation are reported to maintain moderate cut slopes, while weathering of underlying shales may cause rockfalls and slumping. Foundation stability for heavy structures is good except where clays are present. The clays will deform under load when wet.

Joints and minor faulting are common to the Pottsville Formation. Joints are usually widely spaced and are open and vertical.

The bedrock is evident at the toe of the dam. It also is exposed at the abutments.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAUREL RUN NO. 2 DAM

PENNSYLVANIA GAS
AND WATER COMPANY

GEOLOGIC MAP

APRIL 1980 EXHIBIT F-1